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THE FUTURE OF ELECTRIC TRAMWAY TRACTION.

EVERYBODY connected with electric traction must have perused with interest, in the last issue of the ELECTRICAL REVIEW, the paper read by Mr. Leonard on the Sprague system, and the discussion which followed; more especially as, after all the experience gained with different modes of transmitting the electric current to the motor of the car, Mr. Sprague himself was compelled to admit that accumulators are the only safe means as a motive power for street cars, and are, therefore, to be looked forward to in the future as the solution of the difficulty of electric traction for cities and public thoroughfares. All this is very gratifying, but it does not in the least take us by surprise, as in this country there are not many electricians with experience in electric locomotion who would think otherwise, and we must take it that this question has already been settled in everybody's mind. But with regard to the weight of the accumulator, there is still a certain amount of indecision which ought to be settled as soon as possible, as from practical experience it seems that weight, in combination with our present system of storage batteries, is not such an insurmountable obstacle. But everything now seems to show that exaggeration in many points connected with storage batteries is giving place to actual facts, which enable electricians to arrive at more sound conclusions, and so matters settle themselves upon good practical lines, formed from the knowledge which has been gained from a series of different trials. This leads us to believe that what is required in an accumulator is not a large amount of storage capacity, coupled with a minimum of weight, but rather something that will contain a working capacity for, say, between three and four hours, on the best mechanical construction. For instance, a car may be constructed to run 40 miles with one charge, which to all appearances may be eminently satisfactory, but, at the same time, this may be quite inappropriate for the purpose intended, which would be better fulfilled by employing an accumulator enabling it to run only 20 miles, at the same time retaining about one-third of the charge in the cells. Under these circumstances, it would only require accumulators of about 150 ampère-hours storage capacity, of a very practicable size, without any objectionable weight, and would secure good and reliable working, with very little wear and tear. If the storage capacity were increased, so as to run 40 miles with one charge, no advantage is to be gained.

By limiting the storage capacity of this class of accumulators to 150 ampère hours, they would be enabled to run from between three and four hours, and could be constructed on the best mechanical lines without having recourse to the fatal tendency of lightness, which is contrary to all common sense when intended for electric traction.

This arrangement would, in fact, correspond very nearly to the present conditions of carrying on horse traction, for we believe that the useful quadruped is limited to a daily run of 3¼ hours.

Anyone who has read the discussion on the Sprague system can safely come to the conclusion that, although various other systems are worked in America, the practical outcome of all these gigantic works is that storage batteries is the only safe and practical means for street transit.

We will take, for instance, the Elieson locomotive on the Stratford and Manor Park line, coupled to a full sized car with a full complement of 50 passengers, sometimes even amounting to 75, a total weight varying from 12 to 13 tons, and run with an average current of between 25 and 30 ampères, 160 volts, at a rate between 8 and 9 miles per hour. These figures ought now clearly to establish what the cost should be per H.P. hour, reduced to car miles, as compared with our present system of horse haulage. Whatever extravagance may be allowed for wear and tear and depreciation, and under the worse condition of any practical gradient where adherence could safely be obtained, it should not exceed 4d. per car mile as against 5½d., the lowest figure of horse haulage in this country. It is to be regretted that the Elieson Company, after having worked for so many months, and having carried several hundred thousand passengers, does not see its way to equip a sufficient number of cars, and demonstrate the exact cost of working—the only thing now which keeps electric traction from becoming universal. There is not the slightest doubt that when a line is once launched in this country, with a sufficient number of cars *under proper management*, tramway directors will speedily alter their cold and motionless countenance. Let us hope that this may soon be the case, or our American cousins will have to come over here and do the work for us.

ELECTRIC LIGHTING IN MADRID.

THE disastrous fires of the Paris Opera Comique, the Oporto Bacquet Theatre, and of the Variedades Theatre of Madrid, created such a strong feeling in Spain, that the Government issued early in the present year a decree ordering the closing of every theatre which, on the 31st of October ult., had not been fitted with electric light. The decrée, although very arbitrary, has been strictly carried out, and two of the large theatres in Madrid, the Apolo and the Zazuela, are at present closed. The Eslava, Principe Alfonso, Comedia and Lara have been provisionally lighted as detached installations, and can hardly be considered successful. The Teatro Martin, the Circo de Price and the Teatro Espanol are lighted from the central works of a Madrid Company, and reflect great credit on the engineer of

the company, Mr. Jose Casas. The carrying out of these installations has been greatly interfered with by regulations issued by an official commission which was formed to draw up rules to govern the operations. As happens in all countries, and England and Spain are no exceptions, the commissions so formed are composed of lawyers, whose ability generally develops itself in the drawing up of documents which "no fellow can understand," of members of Parliament possessing political power, and whose training has been growing oats, selling cloth by the yard, or the profound study of fluctuations in stocks. On commissions of this sort great pains are taken to describe in legal language the meaning, for instance, of a trunk line, as the farmer, the merchant, and the stockbroker have each their own definition of the word. The farmer says it must be made of wood, and wants the tree specified; the merchant thinks it a box for packing his goods in, and asks whether it is made of canvas or leather; the stockbroker thinks it a railway, and suggests prefixing "Grand" to the Trunk. The lawyer comes to the rescue and writes "not a human trunk," not a tree trunk, not a travelling trunk, not the Grand Trunk, but a main. Then the discussion turns on the meaning of the word main, and so *ad infinitum*. In the case in point, some two months were occupied in drawing up the regulations, and the remaining four months were left to carry out the work. This delay has caused the Opera House in Madrid to be closed for nearly a month, as the installation was inaugurated on Friday, the 9th inst., instead of on the 15th of October ult. The installation is a great success, and is highly spoken of by all those who have seen it. In the machine room are mounted three Hoffman engines, each of about 70 H.P., running at 360 revolutions per minute, and driving direct a Brown patent dynamo, of Swiss manufacture, and known as the Oerlikon type. Each machine feeds 700 glow lamps of 16 C.P., and each circuit is fitted with variable resistances, to produce scenic effects. On the stage blue, red, and white lamps can be used as occasion requires, and there are also types of arc and large glow lamps, which can be moved from one place to another, to suit the scene depicted during the representation. For illuminating the body of the theatre here is no centre light, drooping brackets from the iers of boxes supplying a much larger quantity of light than is required. The large centre light, though not used during the usual performances, is fitted with glow lamps, which will be in service during the masked balls at Carnival time. The effect, looking from the stage, is a brilliant one, and shows off to advantage a very handsome opera house. The footlights are in two series, one white and the second blue. These colours and red are placed in the flies. The boilers employed are three of the Babcock and Wilcox pattern, working at an average pressure of nine atmospheres (we suppose this to mean nine atmospheres over zero, and not over the normal atmospheric pressure, as is our habit of reckoning). In order to find space for the engines and boilers, M. Casas has been obliged to sink the cellar floors of the theatre some 15 feet, and as the engine and boiler room measure some 30 feet by 150 feet, some idea can be obtained of the amount of labour in removing earth, strengthening the foundations of the building, erecting columns, and re-roofing which has been entailed in preparing this splendid locale.

For the above details we are indebted to the local Press of Madrid, and notably to the *Epoca* and the *Correo* of the 10th inst. Our source of information and its technical character must excuse imperfections. During the inauguration on Friday the superlatively fine orchestra, under the direction of Signor Mancinelli, so well known in London, played magnificently the overtures of La Forya del Destino and William Tell, in the presence of over 3,000 persons, including all the members of the Cabinet.

WE believe that the law suit which has been pending between Messrs. King, Brown & Co., of Edinburgh, and the Anglo-American Brush Corporation, is finally set down for hearing in the Scotch Courts on the 27th inst. The question at issue is, we understand, wider in its bearing than that of the previous case in which Messrs. Crompton & Co. figured.

WE hear that the breakage of lamps on the Grosvenor Gallery circuits occurs much too frequently, and one of the directors attributes this to bad manufacture. We should, however, be much more inclined to think that this effect is due to bad regulation of the difference of potential at the lamp terminals.

THE paper which we published last week by Mr. Leonard, showed very clearly the serious drawbacks attached to the working of tramcars by the overhead conductor system, even on a line which is admittedly successful. It gives one the impression that this method of utilising electrical energy is only of a temporary nature, and that the most enthusiastic advocates of the overhead system would gladly abandon it when the opportunity arises to make use of something requiring less care and attention. In fact it is a convenient stop gap pending the general introduction of secondary batteries, but one which, in American hands, can be turned to good account, notwithstanding the almost disheartening difficulties to be overcome.

THERE is a feeling abroad that the Chairman of the Electrical Trades Section of the London Chamber of Commerce would have been best represented in the person of Mr. Herbert Tritton. He is already a V. Pres. of the Chamber, and his appointment would have caused the least jealousy.

THE Committee, which has just elected Mr. R. E. Crompton for its Chairman, and the Earl of Crawford, and Major Flood Page for its Vice-Chairmen, is desirous of proceeding to the discussion of questions primarily affecting the trade. With this object the views are requested of the members of the section at large as to which are, in their opinion, the topics most pressing for immediate consideration. Communications should be sent to Mr. Kenric B. Murray, not later than the 18th instant. The questions which suggest themselves should be inscribed in the order of the importance which is attached to them by the sender.

QUESTIONS are about to be put to the President of the Board of Trade with regard to the operations of certain companies, which propose to distribute the electric light over the Metropolis. It is believed that the plans which these companies have in view will involve an enormous addition to the overhead wires, but is it not more than probable that this is a counter-blast to the gigantic Deptford scheme, originated by those who are interested in the future of the Metropolitan Electric Supply Company? Be this as it may, we hope that the matter will be well considered and that no hasty legislation, to be altered or perhaps overthrown in a few months, will be cast in the path of progress. It is now pretty certain that American experiences of overhead *v.* underground conductors cannot be overlooked in enabling a decision to be arived at, favourable or the reverse, respecting the extension of overhead wires in this country. It may not be uninteresting here to give the opinion of Mr. A. M. Renshaw, general manager of the United States Electric Light Company of Washington, who states that the company has lost during the past few years $20,000 in attempting to make various underground cables answer. Says Mr. Renshaw: "Parties interested in cables will tell you that it is perfectly practicable to make them work, but you can rely upon it that there is no cable in existence that will not give out when steadily subjected to an arc light current of 2,000 volts., and there is no place in the *world* that has maintained such a strain as that above mentioned for a period of two years." Mr. Renshaw advocates the expenditure of extra money for a good and strong overhead line.

A COMMITTEE of the Common Council of Detroit recently investigated the question of the feasibility and the practicability of the City of Detroit establishing and maintaining an electric light plant, and presented a report to their fellow councillors. This was accompanied by a detailed report from Mr. Fred. H. Whipple, the author of a book "Municipal Lighting," scarcely known, we think, in this country, but one which should be in the hands of every electric light contractor. Mr. Whipple was engaged to gather and compile all necessary information upon the various divisions of the subject dealt with by the Detroit committee. And this, again, would prove of great service to English electricians. The committee believes that it has been satisfactorily demonstrated that all telegraph, telephone, and low tension or incandescent light wires can be placed underground without interruption to service; but the question of high tension conductors needs further study, and the committee could not discover any method which would, with certainty, enable this class of wire to be successfully operated underground. The committee concludes its report with the very sensible observation that the subject of public lighting is one of importance to every taxpayer, and that it demands intelligent and considerate legislation. No hasty thought should be given to it, nor should any ill-advised action be taken.

MR. WHIPPLE'S report is of the most interesting character, and although it applies only to American methods of procedure the time may shortly come when we shall find it necessary, or at least politic, to borrow many of the ideas of our transatlantic cousins if we wish to keep pace with the times. One chapter on the cost of public lighting in cities by the rental system is full of valuable statistics, the prices paid in the 118 towns enumerated varying from $40 per arc lamp per year, to $366. Between this maximum and minimum there are no less than 60 different estimates, the average coming out as $141 per arc lamp per annum. Another still more valuable chapter is that upon the cost of lighting in cities which own and operate their plant, and this is followed by a second, highly suggestive, on methods of street lighting; and a third upon underground lines, which teems with valuable data. Several papers on the last-named subject together with the discussions which followed are given *in extenso*. The Waring cables seem to be generally spoken of in favourable terms by those who have used them.

THERE may be a little advantage to be gained by the method of increasing the tractive force on tramways proposed by Mr. Ries. The late Richard Werdermann experimented upon wheels for railway purposes in the same manner, but it was found that the magnetic attraction between rail and wheel was so slight, that it only amounted to the equivalent of about half a ton per wheel, and this added to the total weight of a locomotive, did not amount to much. Tramcars are, however, so light comparatively, that the magnetic effect may materially increase the tractive force. It is a question yet to be decided, however, whether the amount of energy expended in doing this, or in the kind of heating effect which Mr. Ries gives as an alternative method, is not too costly.

IT was an easy matter for the New York authorities to decide that all electric wires should be placed underground; the electric companies find it quite another thing to place them there and work their systems with satisfaction either to themselves or their customers. Many miles of conduit have been laid, and hundreds of miles of wire have been placed in them. But up to the present the results cannot be viewed as satisfactory. The Western Union Telegraph Company complains of a series of 400 wires being ruined by overheating. The pipes of a steam-heating company had in some way heated the conduit almost to the temperature of boiling water and the insulation of the telegraph lines was destroyed. Other companies have made similar complaints. Unfortunately, this is not the worst. The conduits threaten to be a source of injury to life and property. On another page particulars are given of an explosion in a conduit which recently occurred in Boston, and we read in the *Scientific American* of a similar occurrence, on the morning of October 12th, in New York. A heavy thunderstorm, in which the display of lightning was remarkably vivid, was in progress. The usual electrical disturbances were observed in the telegraph and telephone offices. A number of persons standing in the shelter of the Field building, on Broadway, witnessed a more remarkable manifestation. They had just heard a violent thunder clap when a second report, almost simultaneous with it, occurred. It came from the opposite side of the Bowling Green. The iron cover of the subway manhole situated there was blown into the air, and the street pavement was disturbed over an area 20 feet square. A flame, four feet in height, was observed to shoot upward from the place at the same instant. Gas from a leaky main had in all probability found its way into the manhole. The soil is saturated with gas, and the lightning either caused sparking among the metal work and cables in the manhole or directly inflamed the gas, and the explosion as detailed was the result.

ON THE SPEED OF DIFFUSION OF ELECTRO-DYNAMIC ACTIONS.

By H. HERTZ.

(*Concluded from page* 512.)

Interferences at Different Distances.

In the same manner as at the zero point interferences can be elicited at greater distances. But for them to be obvious care must be taken that the action of the wire waves each time shall be of similar magnitude to the direct action, which we can effect by increasing the distance between P and A. The correctness of the following consideration is now manifest: if the action is propagated through the air with an infinite velocity it must interfere with the wire waves in an opposite direction after each half wave-length of the latter, that is after each 2·8 metre. If the action is propagated through the air with the same velocity as the wire waves it will interfere with the latter in the same manner at all distances. If the action is propagated through the atmosphere with a finite velocity, different from that of the wire waves, the interference will change its direction, but at intervals of space greater than 2·8 metres.

In order to ascertain what was actually taking place I made use, in the first place, of that kind of interferences which are observed during the transit from the first to the second main position. The spark interval was above. I confined myself at first to distances up to 8 metres from the zero point. At the end of each half metre of this extent the secondary conductor was examined as to whether any difference could be detected in the spark interval according as the normal was turned towards or away from P. If no such difference existed, the result of the experiment was indicated by the sign ○. If the sparks were smaller whilst the normal turned towards P, the interference detected was indicated by the sign +. The sign − was used to indicate an interference at the opposite direction of the normal. In order to multiply the experiments I repeated them frequently, substituting each time for the wire, *m*, *n*, a wire 50 centimetres longer, and thus gradually prolonging it from 100 to 600 centimetres. The following easily intelligible conspectus contains the results of my experiments:—

	0		1		2		3		4		5		6		7		8
100	+	+	○	−	−	−	−	−	○	○	○	○	○	+	+	+	+
150	+	○	−	−	−	−	○	○	○	○	○	+	+	+	+	+	○
200	○	−	−	−	−	−	○	+	+	+	+	+	○	○	○	○	○
250	○	−	−	−	−	○	○	+	+	+	+	○	○	○	○	○	○
300	−	−	−	−	○	+	+	+	+	+	○	○	○	○	−	−	−
350	−	−	○	+	+	+	+	+	+	○	○	○	−	−	−	−	−
400	−	−	○	+	+	+	+	○	○	○	○	−	−	−	−	−	−
450	−	○	+	+	+	+	+	○	○	○	−	−	−	−	−	−	○
500	−	○	+	+	+	+	○	−	−	−	−	−	○	○	○	○	+
550	○	+	+	+	+	○	○	−	−	−	−	−	○	○	○	○	+
600	+	+	+	+	○	○	−	−	−	−	−	○	○	+	+	+	+

Hence it may almost seem as if the interferences changed their sign after every half wave length of the wire waves. But we remark in the first place that this does not happen exactly. Thus, in the first line, the sign ○ should recur at the distances of 1 metre, 3·8 metres, 6·6 metres, whilst it occurs evidently less frequently. Secondly, we perceive that the displacement of the phase happens more quickly near the origin than at a distance. All the columns agree in this. A change in the rate of propagation is not probable. We rather have good reason for ascribing this phenomenon to the circumstance that we utilise the entire force, which may be separated into electrostatic and electrodynamic forces. Theory renders it probable that the former, which predominates near the primary vibration, diffuses itself more rapidly than that which at greater distances comes almost exclusively into operation. In the first place, in order to ascertain the reality of the phenomena at a greater distance, I have for three values of the length, *m*, *n*, extended the experiments to a distance of 12 metres, which was not possible without some difficulty. Here are the results:

	0	1	2	3	4	5	6	7	8	9	10	11	12
100	+	○	−	−	○	○	○	+	+	+	+	+	○
250	○	−	−	○	+	+	○	○	○	○	−	−	−
400	−	○	+	+	○	○	−	−	−	−	○	○	○

If we may venture to assume that at greater distances only the inductive effect comes into play, we shall infer from these observations that the interference with the wire waves changes its sign only about every 7 metres.

In order to investigate the inductive force near the primary vibration, when the phenomena are more distinct, I made use of the interferences which occur in the third main position, whilst the spark interval is turned 90° away from the fundamental line. The direction of the interference at the zero point has been already mentioned and will be indicated by the sign −, whilst the sign + will indicate an interference on passing the waves along the side of C turned away from P. By thus selecting the signs we place ourselves in agreement with the previous choice of the signs. For, since the force of induction is opposed to the total force at the zero point our first table would begin with the sign − if the influence of the electrostatic force could be removed. The experiment shows in the first place that interference still occurs at a distance of 3 metres, and has the same sign as at the zero point. This experiment, which was repeated without any doubtful results, is sufficient to prove the finite velocity of diffusion of the inductive effect. Unfortunately, by reason of the weakness of this kind of sparks, the experiments could not be extended to a greater distance than 4 metres.

In order to demonstrate a displacement of the phase within this limit, I repeated the experiments with various lengths of the wire, *m*, *n*, and I subjoin the results:

	0	1	2	3	4		0	1	2	3	4
100	−	−	−	−	○	400	+	+	+	+	○
150	−	−	○	○	○	450	+	+	+	○	○
200	○	○	○	+	+	500	+	+	○	○	○
250	○	+	+	+	+	550	+	○	○	○	−
300	+	+	+	+	+	600	○	−	−	−	−
350	+	+	+	+	○						

The discussion of these results shows that here, also, the phase of the interference alters with the increase of distance, and in such a manner that, at a distance of 7—8 metres an inversion of the sign is to be expected.

But this result comes out much more distinctly if we combine the observations of the second and of the third table, using the results of the latter up to a distance of 4 metres and beyond that distance those of the former. In the first mentioned interval we avoid the influence of the electrostatic force by the peculiar position of our secondary conductor, in the latter this influence falls away by the rapid decrease of the electrostatic force. We might expect that the observations of both intervals would connect themselves together, and we find our anticipation confirmed. We thus obtain by the juxtaposition of the signs the following table for the interference of the electro-dynamic force with the action of the waves in the wire.

	0	1	2	3	4	5	6	7	8	9	10	11	12
100	−	−	−	−	○	○	○	+	+	+	+	+	○
250	○	+	+	+	+	+	○	○	○	○	−	−	−
400	+	+	+	+	○	○	−	−	−	−	○	○	○

Upon this table I found the following conclusions:—

1. The interference does not change its sign every 2·8 metres. Therefore the electro-dynamic effects do not diffuse themselves with infinite velocity.

2. The interference is not in an equal phase at all points. Therefore the electro-dynamic effects do not diffuse through the atmosphere with the same velocity as do the electric waves in wires.

3. A gradual retardation of the waves in the wire causes any given phase of the interfence to travel towards the origin of the waves. From this direction of the movement it follows that of the two diffusions (differing in velocity) that through the atmosphere is the more rapid. For if by the retardation of one of the two effects we produce an earlier coincidence of both we have retarded the slower one.

4. At intervals of about $7\frac{1}{2}$ metres each the sign of the interference is inverted. After traversing $7\frac{1}{2}$ metres, therefore, the electro-dynamic action overtakes a wave in the wire. Whilst the former has travelled 7·5 metres, the latter has travelled $7{\cdot}5 - 2{\cdot}8 = 4{\cdot}7$ metres. The proportion of the two velocities is therefore 75 : 47, and the half wave length of the electro-dynamic action in the atmosphere is $2{\cdot}8 \times 75\,47 = 4{\cdot}5$ metres. As this distance is traversed in 1·4 hundred-millionth of a second, the absolute velocity of the diffusion through the air is 320,000 kilometres per second. This result has only an ordinal accuracy, but the true value can scarcely be more than $1\frac{1}{2}$ times as much, and scarcely less than two-thirds of the figures given. The true value can only be determined by experiment as soon as the velocity of electricity in wires is determined more accurately than heretofore.

As near the primary vibration the interferences certainly change their sign after every 2·8 metres, we might conclude that the electrostatic force, which is here pre-eminently active, diffuses itself with an infinite velocity. But essentially this conclusion would depend upon a single change of sign, and this one change (independently of each displacement of phase) is explained by the circumstance that at some distance from the primary vibration the total force changes the sign of its amplitude. If, therefore, the absolute velocity of the electrostatic force is for the present unknown, we have definite reasons for assuming that the electrostatic and the electro-dynamic forces have each a different velocity. The first reason is that the total force does not disappear in any point of the fundamental line. As the electrostatic force predominates near at hand, and the electro-dynamic force at a distance, it follows that in a mean position both must act equally and in opposition, and as they do not destroy each other, they must at certain times meet in this position.

The second reason is taken from the distribution of the force through the entire space. In what manner the direction of the force can be ascertained at any given point has been explained in a preliminary memoir (*Wied. Annalen*, 34, p. 155. 1888.). The distribution of force has there also been mentioned, and it has been remarked that there are four peculiar points in the horizontal plane, about 1·2 metres before and behind the outer margin of our plates, A and A′, in which a definite direction of the force cannot be indicated, but it acts in all directions with approximately equal strength.

This seems to be explained only by inferring that here the electrostatic and the electro-dynamic components meet perpendicular to each other and are approximately equal, with a perceptible difference of phase, so that they do not combine to a resultant vibrating rectilinearly but to a resultant which, during each vibration, passes through all the points of the compass.

The circumstance that different parts of the total force have a different velocity is important, as affording an independent proof that at least one of these parts must distribute itself with a finite velocity.

Conclusions.

In the quantitative results of these preliminary experiments improvements of greater or less importance may be effected by subsequent researches. But the track on which such researches have to proceed may be considered as opened. The fact that the effects of induction diffuse themselves with a finite velocity may be regarded as demonstrated. These results involve manifold consequences, a few of which I may be permitted to mention.

1. The immediate inference is the confirmation of Faraday's view that the electric forces are independent polarisations existing in space. For in the phenomena which we have examined, such forces still exist in space after the causes which have produced them have disappeared again. These forces, consequently, are not purely parts or attributes of their causes, but they correspond to changes in the conditions of space. The mathematical determinations of these conditions justify us in characterising them as polarisations, whatever the nature of such polarisations may be.

2. It is certainly worthy of note that the proof of a finite velocity of diffusion should be given first for a force which decreases inversely as the distance and not as the square of the distance. But it must also be mentioned that this demonstration cannot remain without reacting upon such forces which are inversely as the square of the distance. For we know that the gravimotoric attraction between currents and their magnetic actions are most closely connected with the inductive effects by the principle of the conservation of energy as it seems in a relation of action and reaction.

If this relation is not simply a deception it is not readily intelligible how one action can extend itself with an infinite and the other with a finite velocity.

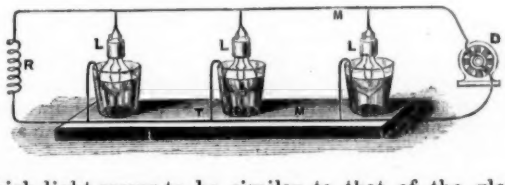
3. The hypothesis that the transverse waves of light are electro-dynamic waves, supported by many arguments of probability, gains firm ground by the demonstration that there are really electro-dynamic transverse waves in the atmosphere, and that these travel with a velocity similar to that of light. The way is open for the definite confirmation or refutation of this important view. For there is a possibility of the experimental study of electro-dynamic transverse waves, and of comparing their properties with the properties of the light waves.

4. The open questions of electro-dynamics concerning open currents will now more readily admit of an answer. Some such questions are solved at once by the results already arrived at. In as far as in electro-dynamics we only lack the knowledge of certain constants, the results obtained may possibly suffice for a decision between the conflicting theories, provided that one of them at least is correct.

At present I do not enter upon such applications, as I wish to await the results of further experiments.—*Wiedemann's Annalen.*

A CURIOUS LIGHT EFFECT IN INCANDESCENT LAMPS.

F. J. CROUCH, of Eugene City, Ore., calls attention, in the *Electrical World*, to the phenomenon presented by an experiment which he recently made and upon which he would like to hear the opinion of others. The accompanying sketch shows the arrangement by which a peculiar light is furnished by the electric current,



which light seems to be similar to that of the glow-worm or fire-fly. With three Bernstein lamps he obtained a beautiful moonlight effect, sufficient to read by in a large room.

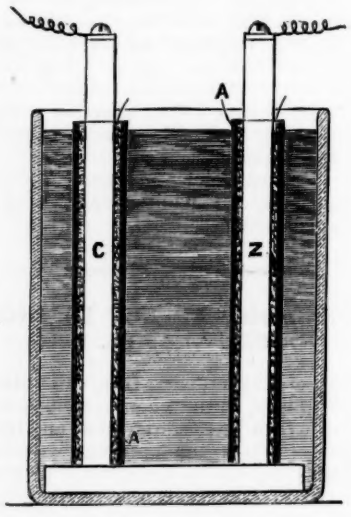
By reference to the sketch one may at a glance see how it is produced. M, M, are the main wires to and from an alternating dynamo, D. From one side of the circuit are hung the lamps, both poles of each lamp being connected together. At the end of this wire is a

resistance coil, R, of about 2,000 ohms (or a resistance offered by 80 Bernstein lamps in series), which connects one side of the circuit to the other, which leads to the opposite pole of the dynamo.

Each lamp is placed within a tumbler filled with a strong brine (of common salt), thus partially immersing each lamp. From the bottom of each tumbler a copper wire reaches over the rim and is then connected to the return wire, as shown. Now when the dynamo is started the light appears, and the light waves pass through the glass. Is this due to leakage, or is it due to a static electric effect? Mr. Crouch would be glad to know if this experiment has ever been tried before, and to hear the opinions of others as to the cause of the phenomenon.

FAURE'S NEW SECONDARY BATTERY.

IN a patent recently issued to M. Camille A. Faure, the inventor describes a form of cell embodying several novel points. In the new battery, M. Faure employs two elements widely separated in the electromotive scale. They are composed of finely divided particles pressed together in a self-supporting mass or body, or composed of plates of metals having combined therewith finely divided and compressed particles of the same metal. Each element is enclosed by a diaphragm or septum of prepared asbestos, which consists of sheets $\frac{1}{32}$nd inch thick, dipped into a solution of soluble salt, such as the chloride of calcium or the chloride of barium. The sheet is then dried, after which it is dipped into a solution of a soluble silicate, such as the silicate of soda or a fluosilicate, which are capable of producing with the first-named substance an insoluble compound.



The elements so prepared are placed in a cell containing an electrolytic solution, which must be of such a nature that in the process of electrolysis it forms an insoluble compound with the metal or metals composing either or both elements. Thus M. Faure takes zinc and copper, and combines with the zinc finely divided zinc, and with the copper finely divided copper. The electrolytic solution preferably employed contains the phosphate of potash.

The accompanying cut (reproduced from the *Electrical World*) shows the cell diagrammatically. C and Z are copper and zinc plates, having combined with them the same respective metals in a finely divided compressed state. These are wrapped with asbestos, A, prepared in the manner described above, and immersed in the proper solution containing phosphate of potash.

On subjecting such a cell to the action of an electric current, phosphate of copper is formed upon the surface of the copper element, the phosphoric acid for this purpose being electrolytically separated from the solution, and combines with the copper to form an insoluble compound—*i. e.*, the phosphate of copper. M. Faure then substitutes a fresh solution of phosphate of potash for the exhausted solution, and upon connecting the battery in a simple circuit for the purpose of discharge, phosphoric acid is transferred from the solution to the zinc, and from the copper to the solution, so that the solution remains unchanged as regards its constituent elements. Of course this preliminary preparation would be avoided if phosphate of copper were placed upon the copper element in the first instance; but phosphate of copper is not easily obtained and manipulated, and the process described is said to accomplish the object desired.

THE RIES ELECTRIC RAILWAY.

MR. ELIAS RIES, of Baltimore, informs us that his "electric railway is now nearing completion, and that it will shortly be placed in practical operation." At the same time we are favoured with a pamphlet mentioning a number of devices which that gentleman has invented, but we are not informed whether all or any of them will be put to the test on the projected railway. Among these devices is, firstly, an electro-magnetic traction increasing apparatus. Wire coils are wound upon the axles, which, together with the wheels, are converted into electro-magnets the instant a current is sent through the said coils from a battery or other source of electricity. Each wheel becomes a pole of an electro-magnet whose circuit is completed through the track rails and axles, and it thus offers resistance to slipping or skidding on grades where the natural adhesion of the wheels would be deemed insufficient. Secondly, increasing traction by sending the electric current from the forward to the rear pair of driving wheels through the intervening portion of the rails. This passage of the current from the wheels into the rails and back produces a temporary molecular change at the points of contact which increases tractive adhesion. Thirdly, double overhead conducting wires of silicon or aluminium bronze, with duplex current collectors which are supposed to avoid "flashing." Fourthly, an overhead single post girder conductor. "This comprises a light, rigid and ornamental single post structure, the conducting portion of which consists of a continuous self-supporting girder or beam, provided with flanges upon or between which the current collecting trollies are free to move. This structure is designed to take the place of the ordinary overhead wire or wires, where a better and more substantial equipment is desired." Fifthly, underground conduits and current collectors for electric railways. "A peculiar arrangement of horizontal contact wheels is employed, by means of which permanent rolling contact can be maintained with the conduit conductors, and the objectional wear due to the use of brushes and the consequent deposition of particles of metal on the interior of conduit is entirely obviated. These contact wheels are, moreover, capable of horizontal motion between the parallel conductors, so that by a simple movement of the motorman's lever the car may, if desired, be run forward, backward, or stopped by simply changing the position of the collecting wheels with respect to the parallel conductors and without the use of any additional switching devices." Nothing is said about the life of such rollers and the probable state of the conducting surfaces after such switching and reversing has been performed a certain number of times. Sixthly, electric railway crossing, where the collecting devices are so arranged that no interruption of contact takes place in passing the break, contact on one side being made before that on the other is broken. Eighthly and ninthly, a combination of line conductor

and secondary battery. "The motor cars are each supplied with a few cells of a secondary battery, sufficient to contain from one to two hour's supply of propelling current. The cells are automatically kept up to the normal charge from the line conductors when the car is running, and this stored energy is employed to propel the car when it arrives at a cut-out section. It is also available for propelling the cars at any time in case of accident at the generating station, or a break in the line conductors at any point."

As Mr. Ries states in another part of his circular that the supply current is maintained at 300 volts, this having been found to be the most satisfactory for street railway motors, we wonder how the "*few cells of secondary battery*" in each car are joined to the conductor circuit. Altogether, there are in this circular sixteen "systems," or parts of systems, in the name of the inventor, but we do not find sufficient description to be able to judge as to what will be claimed as original, and we await with interest the practical results when these devices have been put into everyday use. On reading page 17 of the pamphlet, we were almost taken by surprise; this short chapter is headed, "The Return of Power on Descending Grades;" and here we find an old idea rejuvenated and attached to the system under discussion. Mr. Ries does not seem to be aware that a similar method was suggested by the late Sir William Siemens when the Portrush Electric Railway was first projected, and that the idea in the abstract did not even originate with Sir William, but with the advent of the storage battery. We reproduce portion of this advertisement, in the hope of amusing some of our readers. It runs thus:—"However, another and different adaptation of the secondary battery principle to electric railways, in which the motor cars normally derive current from supply conductors, is embraced in the Ries electric railway system. This method is particularly adapted for railways having a number of grades, and in such cases is of the utmost importance and value, from an economical standpoint. In this instance the secondary battery carried by each motor car is not charged with current from the supply conductors of the railway, as in the organisation before described, but the electro-dynamic motor is *automatically changed into a generator* whenever the car or train is coming to a stop, and when descending a grade, and the current thus generated under the influence of the surplus energy or momentum of the car or train *is fed into the secondary battery*, where it is stored in the form of chemical energy for the time being, ready to be given out as useful work whenever required. *This stored energy is automatically given back to the motor* when the car is about to start or is ascending a grade, and serves to reinforce the line current and co-operate with it in overcoming the inertia of the car, and in propelling it up hill. . . . . There is, however, another advantage connected with this method of operating cars or trains, and this arises from the fact that by converting the motor into a generator the motion of the car or train is retarded, this retardation being directly proportional to the amount of current the motor is generating. This fact is taken advantage of in regulating the speed of the cars on descending grades and for bringing the car or train to a stop without the use of special braking devices other than furnished by the revolving armature of the motor itself. Thus it will be apparent that by properly combining the secondary battery and supply conductor system as just shown, the greatest possible economy and flexibility are secured, and results obtained that have never before been equalled." (!) Does Mr. Ries not know that the motor when working as a generator has to run faster than under normal conditions in order to overcome the counter E.M.F. of the battery, and that it ceases to generate the moment its speed is reduced by but a few per cent.? Instead of utilising as a brake power the momentum of the car for charging the cells, he will find that the same will be *discharged* at a high rate. We only hope Mr. Ries will reconsider the subject before applying this combination in the manner indicated.

STREET RAILWAY MEN IN COUNCIL.

Electricity crowding other topics out.

The American Street Railway Association is an important body composed of presidents, directors, managers and engineers of tramway companies and others interested in the progress of street railways or, as we term them, tramways, and their equipment. Once every year members from all parts of the States flock together with the object of discussing questions of mutual interest and of reading papers on subjects relating to permanent ways, rolling stock, horses and their management, stables, manure, fodder, mechanical propulsion and similar topics.

Although experiments with electric cars were made and published years ago, the "Convention" almost ignored the subject, and treated electricity as an agent for tramway propulsion with silent contempt. Believers in electric traction expressed their views to the Convention of 1886, but comparatively little attention was paid to the speakers by the bulk of the meeting. Such rapid strides, however, were made in the development of electric tramways during the ensuing year that the question had to be taken up seriously, and with the proverbial American spirit, members not only lent a willing ear, but many became thorough converts during the meetings of 1887 at Philadelphia, where electricity formed the main topic of discussion.

Mr. W. Wharton read a lengthy and thoroughly practical paper, which, coming from such a source, was listened to with the greatest attention; several of the leading street railway men supported the views of Mr. Wharton, and those who were still inclined to scepticism had ample opportunities of satisfying themselves with the performance of Reckenzaun's car which was running in the streets of the Quaker City, and which brought the members of the Street Railway Association from distant parts to the headquarters of the Convention. It was generally admitted that Mr. Reckenzaun's presence in the States, his earnest lectures, and his successful work with storage battery cars, gave a great impetus to this new enterprise, and the Americans have shown their fullest appreciation of his abilities.

This year the electrical delegation was stronger still, and it is reported that electricity came in for the lion's share in the transactions of the Washington Convention.

There was Mr. Bracken of the Julien Company, who gave an eloquent address on the advantages of storage battery cars. He not only stated what had been done by the Julien Company, but gave a comprehensive sketch of the work done up to date generally in the sphere of street car traction. On being questioned as to the cost of a car, Mr. Bracken stated that a regular 16 foot car with two sets of batteries and motors complete would cost $4,000; with regard to the life of the cells, the speaker stated that some of the cells have been in use on the Pennsylvania Railroad for two years, and added, that if the batteries only lasted six months, he would guarantee to replace them more cheaply than horses.

Mr. T. C. Barr, the president of the Lombard and South Street lines, Philadelphia, stated that they had a storage battery car (Reckenzaun's type) running on their tracks. It is a 22 foot car, with trucks, weighing in the aggregate 14,800 lbs.; the whole of the equipment was made by the Electric Car Company of America. The car would seat 34 passengers, and they often crowded in altogether about 125 people. They got very satisfactory results, the car running smoothly and nicely, starting off without a jerk, or any movement that would be noticed by the passengers. As to cost, Mr. Barr stated that it took 3½ hours to charge the batteries, and they estimated that at 60 cents. Taking 80 miles as a day's work for a car, it made in the neighbourhood of 9 dollars as the cost of operating that large car per day, including the wages of the conductor and driver, as well as the cost of power. The car was operated once on one charge for 63 miles, but it would

not do that when subjected to constant stopping and starting. Mr. Barr hoped to bring about the final adoption of this system.

Mr. Frank Sprague made a statement as to the well-known results obtained on the Richmond electric road, where the cars now had run 500,000 miles and carried over a million passengers, and where the cost of power per car per day did not exceed $1.50, exclusive of wages of men and repairs. On the question of overhead line he remarked it was a matter of outlay. In Boston, on the West End road, the cost would run five times as high as at Richmond, handsome iron poles being used in Boston with span wires, practically impossible to break, and the poles being imbedded deeply in cement. The station would have 410 H.P. of steam plant and 450 H.P. of dynamos. With the overhead conductor in Boston a conduit system would be combined, and all the work would be an immense advance on that in Richmond. There will be 20 cars running. In reply to interrogations respecting the Richmond road, and the number of cars that had been disabled at a time—28 out of 40 it was asserted—Mr. Sprague stated that he was not responsible for bad local management, where the cars had been allowed to stay in the street unhoused for 9 or 10 months, and where cars had been run through water up to their axles. When questioned as to the cost of dynamo repairs, Mr. Sprague said it should not exceed 5 per cent. per annum. There seemed to be an idea because of certain accidents that had happened that the electrical traction people had learned nothing; but there was nothing in which there had been more advance. They had not spent money without finding out the evils and their cure. The evolution up to perfection of apparatus was inevitable, and the stages of thoroughly practical successful operation had already been reached and passed.

Mr. R. W. Blackwell, of the Bentley-Knight Company, said that many of the promises he made at last year's convention had been fulfilled in their road at Allegheny. They were now building a three mile section of conduit for the West End road of Boston, running through some of the finest streets in that city. Mr. Blackwell closed with the pertinent remark that when the members put in their electric roads they should see that the motors had care, just as horses had had, the skilled mechanic taking the place of the veterinary surgeon.

Mr. G. W. Mansfield referred to the work done in the field of electric traction by the Thomson-Houston Company, and he made an effective appeal for co-operation in the work between street railway men and electrical engineers, in the interchange of ideas, information and experience.

Mr. Bracken, on a motion adopted to appoint a committee which should secure and furnish certain data, suggested that it would be well to include in that some figures as to the actual cost of operation. They had heard Mr. Holmes give 24⅔ cents as the cost of operating per horse-car mile in Chicago, and that figure had surprised many. Various statements had been made as to the cost of operating a 16 foot car with horses, ranging from $4.50 to $7.50 per day. Electricity would compete with that. The compilation of reliable statistics would be a very valuable work.

OCEAN TEMPERATURES AND SUBMARINE CABLES.

THE following remarks were forwarded to us by Mr. C. Bright, as supplementary to the observations made by him at the recent meeting of the Society of Telegraph-Engineers and Electricians:—

As regards the conductivity of copper referred to by Mr. Lant Carpenter, I would remark that the 102·38 per cent. mentioned by him is at the present time quite an ordinary conductivity for copper intended for telegraphic purposes, and consequently the correct coefficient for variation of resistance by temperature is frequently somewhat higher than that given for Dr. Matthiessen's standard, pointing to the desirability of a fresh standard being adopted.

Inasmuch as the resistance of gutta-percha is effected so much more sensibly by a change of temperature than that of copper, it is sometimes, in the case of gutta-percha cores, a good plan to calculate the temperature by the variation of the dielectric resistance as well as by that of the conductor, merely as an occasional check on the coefficient for variation by temperature of the resistance of the copper conductor. By reason of the effect of pressure on the resistance of gutta-percha, too much reliance cannot be put in such results, especially owing to the possibility of the presence of an incipient or variable fault. Moreover, this plan is not as a rule carried out in submarine cores, owing to the additional effect of the weight or pressure of the water above the cable on the resistance of any fibrous material, such as gutta-percha, and to the fact that no such effect occurs visibly on any metal substances such as copper, whose hardness prevents their being condensed by any physical agencies.

No theory has been advanced in the paper as to the different physical effect produced by a change of temperature which causes the resistance of metals, such as copper, to be decreased by a cold temperature, and that of vegetable fibrous substances like gutta-percha or India-rubber to be increased thereby, and *vice versâ*. The physical effect is presumably the same in both cases as that of pressure of the water, only materially more marked. The effect of pressure is that of condensation. In the case of a metal no sensible change is produced thereby, owing to the already highly condensed state; but with vegetable fibrous substances, like gutta-percha or India-rubber, the effect is highly sensible. These materials are naturally of a porous character; but when subjected to pressure become less so, and consequently tend to absorb less water, the presence of which, especially as regards salt water, naturally lowers the resistance of such materials; moreover, the mere fact of increased homogeneity is sufficient to account for increased resistance by less loss of current laterally.

The late Sir William Siemens first demonstrated the effect of pressure on insulating substances in a paper on the subject read before the British Association in 1863, based on experiments on the gutta-percha core of the first Malta-Alexandria cable, as well as on the Cathagena-Oran G.P. core, and on certain India-rubber cores. Herein he pointed out how the resistance of gutta-percha was materially increased by pressure, and in direct proportion to the degree of the same, which was varied as desired in the pressure tanks of Reid. The formula, given in the paper before us, expressing the increase of the resistance of gutta-percha by pressure, was given by Siemens as the result based on these experiments, where the coefficient 0·00023 was the amount of increase in resistance found to occur on a unit resistance by a unit pound pressure. It will be seen, therefore, that this formula was not one of the many introductions due to Mr. Latimer Clark, as stated in the paper, but is due, rather, to Sir W. Siemens. Messrs. Bright and Clark tested the first Persian Gulf core under pressure, finding the gutta-percha to be increased in resistance 2·6 per cent. for every 100 lbs. pressure; whereas Siemens's experiments showed the dielectric resistance of the Malta-Alexandria core to be increased only 2·3 per cent. thereby. In Bright and Clark's experiments 600 lbs. was, however, the maximum pressure, being equivalent to only 224 fathoms of sea water, whereas in those of Siemens a pressure equal to about 1,700 fathoms was applied. The most useful way in practice of expressing the increase of the resistance of gutta-percha by pressure on submergence is, I think, to say that it is increased 6·2 per cent. for every 100 fathoms depth of sea water. It is not absolutely certain whether the pressure test as applied to a core represents quite the same thing as a sheathed cable when submerged. In this test it is necessary to keep the core for some time under the required pressure before noting the effect on the insulation resistance, as the application of pressure increases the temperature for the time being, and consequently a

change in resistance at that time would be partly due to the change of temperature, just as the withdrawal of the pressure also has the effect of temporarily lowering the temperature of the water. Most forms of India-rubber cores are more absorptive than a gutta-percha core, owing largely to the fact that the rubber, as a rule, is of necessity laid on the wire in strips either spirally or longitudinally, thus involving a continuous seam instead of being applied round the wire in a homogeneous tubular form as in the case of a gutta-percha core. Siemens found that some forms of masticated India-rubber were decreased in resistance by pressure at a rate about one-fourth of that at which gutta-percha is increased by a corresponding amount. The formula expressing the decrease of resistance of such India-rubber by pressure would be

$$R\,p = R\,[1 - (0{\cdot}000061 \times p \text{ lbs.})]$$

where R is the original resistance ; 0·000061 the coefficient of decrease of resistance on unit resistance (1 megohm) by unit pressure (1 lb.) ; p the number of lbs. pressure applied and R p the increased resistance by pressure. Fairbairn found, on the other hand, that some forms of India-rubber were very slightly increased in resistance by pressure. In any case the resistance of any description of India-rubber can be but little improved by pressure due to submergence as compared with gutta-percha, owing to its higher absorptive power. Most mixtures of vulcanised India-rubber being more homogeneous and less absorptive (like gutta-percha) are not, however, affected materially by pressure in either direction.

The nature of the physical change produced by a change of temperature on vegetable substances of the gutta-percha and India-rubber order is that of cold contracting the material and heat expanding it. Thus by contraction the pores of the material are closed by its molecules being brought closer together and consequently it is more compact in its texture, its absorptive tendency is proportionally decreased, and as a result the electrical conductivity is decreased. The effect of heat on fibrous materials, such as gutta-percha and India-rubber, is that of expansion separating the pores and thus increasing the absorptive tendency and lowering the resistance by this and by the decreased homogeneity of the texture. The fact that temperature exerts an opposite influence on the conductivity of metals and vegetable materials cannot be satisfactorily explained physically.

In 1863 Messrs. Bright and Clark conducted a series of experiments on the gutta-percha core of the first Persian Gulf cable in order to determine precisely the nature and degree of the variation of the resistance of gutta-percha due to temperature. The results of these experiments showed that the resistance of gutta-percha was increased very considerably by a decrease of temperature and *vice versâ*—not in simple proportion to each alteration of temperature but by compound interest, as shown in the diagram of Mr. Carpenter's paper.

The resistance of India-rubber is somewhat similarly increased by a fall of temperature and decreased by a rise thereof, but mixtures of India-rubber when vulcanised are considerably less affected by temperature than gutta-percha. Vulcanised rubber being less affected by temperature and pressure than gutta-percha or unvulcanised India-rubber, it is much less improved as an insulator by submergence under any considerable depth of water. According to Mr. Bruce Warren's determination, the coefficient for variation of resistance by temperature of the favourite form of Hooper's vulcanised rubber is less than half that for the variation of gutta-percha resistance. The degree of variation of resistance by temperature (as also by pressure) of India-rubber, even when vulcanised, differs very much, however, for the different "mixtures." The amount of variation by pressure and temperature depends principally on the degree of specific resistance, and according to the amount of moisture contained by them ; thus, mixtures with a low resistance are very much more affected than those with a very high resistance (in the same way that gutta-percha, which often has a resistance at 75° Fah. about $\frac{1}{70}$th of that of Hooper's rubber, is more affected by temperature), thus the coefficient for variation of resistance by temperature of some forms of vulcanised India-rubber, with a resistance but little above that of gutta-percha, is more than double that for vulcanised rubber with the highest resistance, or nearly as much as that for gutta-percha.

The same applies only to a less extent as regards the different gums of gutta-percha. For this reason the coefficient of variation of resistance represented by the curve in the diagram attached to Mr. Lant Carpenter's paper cannot be said to apply to gutta-percha in general, but only to the particular gum on which the experiments were made, from which the coefficient corresponding to the curve was deduced. Owing to the alteration in the gums at different times it would be desirable, strictly speaking, to calculate a separate coefficient for variation of resistance by temperature for each separate core made. Considering, however, that the resistance of gutta-percha varies so much by age (owing to other circumstances besides changes of temperature), such calculations and corrections of resistance for temperature can only be correct for the time at which the degree of variation of the resistance by temperature was first noted. I do not think this fact is sufficiently appreciated.

When a cable with a gutta-percha insulator is submerged under a depth of 2,000 fathoms of the ocean, where the temperature is 36° Fah., and where the weight of sea water above it is equivalent to 5,352 lbs. (or about 2¼ tons) per square inch, the insulation resistance is increased 1,145 per cent., of which 1,022 per cent. is due to the decrease of temperature from 75° Fah. to 36° Fah., and 123 per cent. to the pressure exerted on it. Thus the decrease of temperature has taken a nearly 10 times greater share in the increase of resistance than the pressure has. To take a practical example : an original resistance of 600 megohms per N.M. at 75° Fah. at atmospheric pressure, becomes at this depth 7470·6 megohms per N.M., equivalent to an increase of 6870·6 megohms, 6,737 of which is due to temperature, and 738·6 to pressure. In many waters, however (such as in the Atlantic, for instance), the temperature does not fall below the said 36° Fah., which it very ordinarily attains at about the aforesaid 2,000 fathoms depth, so that in the case of submergence under greater depths the resistance of the dielectric will be no further increased by temperature, though it will continue to be increased by pressure in direct proportion to the increase of depth. Thus, when the same cable is submerged under a depth of 3,000 fathoms, in a case where the bottom temperature is 36° Fah., and where the pressure of a column of water of this height is 8,028 lbs. to the square inch, then the resistance will, by pressure, be further increased by 4,598 megohms, *i.e.*, from 7,470·6 megohms at 2,000 fathoms to 12,068·5 at 3,000 fathoms. Thus the total increase of resistance due to the pressure of this depth is 5,336 megohms, or 889 per cent., whereas that due to the 39° decrease of temperature from 75° to 36° Fah. is 6,132 megohms, or 1,022 per cent. From this it will be seen that there is thus a material reduction in the difference between the relative effects of temperature and pressure at 3,000 fathoms, as compared with that at 2,000 fathoms. In fact, at great depths, pressure takes nearly as much part in increasing the dielectric resistance of a cable as temperature does, which, though it falls rapidly just below the surface, does so very gradually lower down, until at a certain depth it falls no further. Vulcanised India-rubber cores, especially, are nearly as much decreased in dielectric resistance by pressure at great depths as by temperature, and at depths beyond 3,000 fathoms the effect of pressure is, under some circumstances, even greater than that of temperature, probably.

Temperature affects the electro-static capacity of a cable, in so far as its affects the resistance of the insulating medium. That is to say, materials with the highest resistance usually offer facilities for the lowest capacity and *vice versâ*. Moreover, when the resistance of gutta-percha is increased as by a decrease of temperature, its capacity also is, as a result, at the same time

decreased (owing to a specific change in the material) though in a much less degree. It would probably be decreased in a much more proportional degree to the increase of resistance, but for the fact of the cold temperature having also, by contraction, the effect of bringing the two plates of the Leyden jar closer together. The capacity of India-rubber is less altered than gutta-percha by temperature, in fact, scarcely at all—some mixtures are increased and others decreased in capacity thereby, but all in a very small degree.

In his experiments with pressure, Sir W. Siemens did not find that the capacity of either gutta-percha or India-rubber was affected by pressure. It is probable, however, that pressure, inasmuch as it increases the resistance of gutta-percha, will, like a cold temperature, tend indirectly to be the cause of a slight decrease of capacity, but whereas pressure produces so much less effect than temperature on the resistance of gutta-percha, its effect on the capacity is imperceptible; indeed, the same counteracting tendency by condensation of the Leyden jar taking place, the capacity can, in any case, be but very slightly affected by pressure. Inasmuch as pressure tends to decrease the resistance of some forms of India-rubber, it also tends to increase the capacity thereof, in the same way that a cold temperature does.

GILBERT'S SHACKLE BALL.

TOO much importance cannot be attached to the proper insulation of the wires, on terminal poles at large junctions, to avoid weather contacts in the apparatus. The above illustration, which is reproduced from a photograph, shows how such can be attained by the introduction of a ball insulator in front of the ordinary Bright's shackle.

On this junction pole there are represented 64 balls, and since their adoption, over 12 months ago, the improvement in the working of the circuits is said to be most satisfactory, as previously the contacts between the various wires, especially when high tension currents were used, were most annoying and impeded efficient working.

It may be mentioned that several hundreds of these balls are now in use, the additional cost of which is well compensated by the admirable and permanent results.

ELECTRIC WELDING.

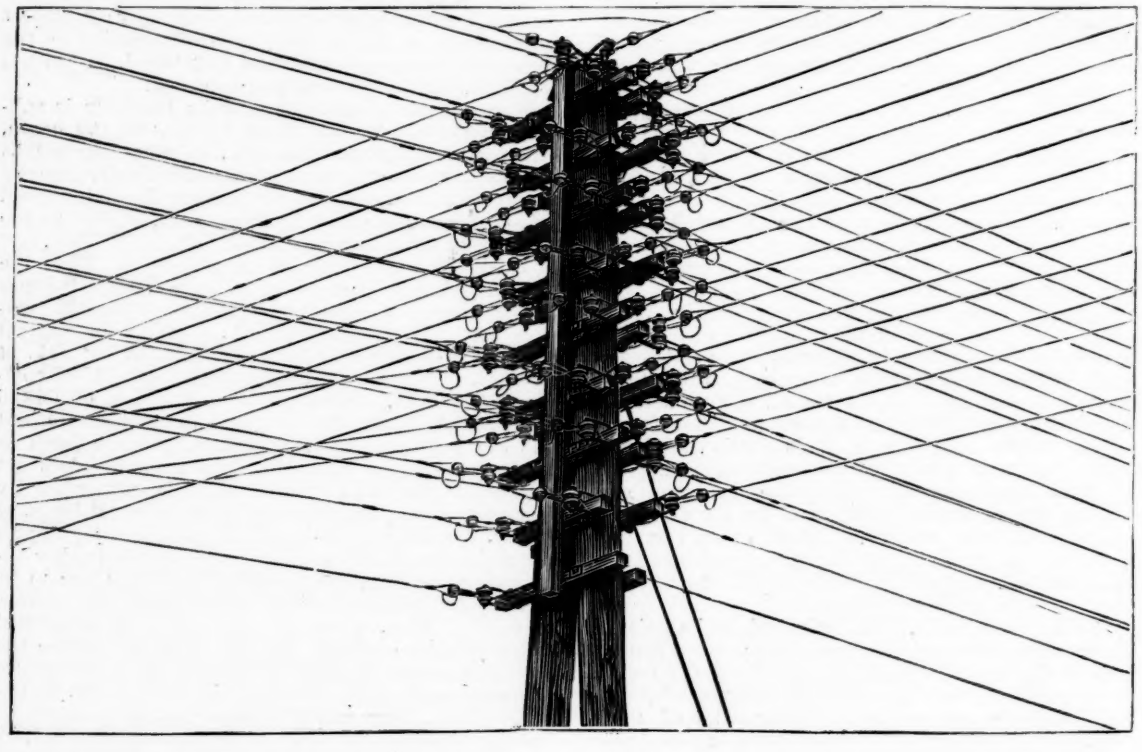
[*Abstract of remarks made by Prof. Elihu Thomson, on showing his electric welding apparatus in operation, at the meeting of the Franklin Institute, held September 19th*, 1888.]

ABOUT a year and a half ago I gave a description of the newly-developed art of electric welding, calling attention to the principles underlying its practice and the results accomplished in the welding of various metals and alloys.

On the present occasion the purpose is to show the apparatus—or, at least, a few forms of it—in operation, and to describe the working and construction.

Quite a number of types of apparatus have been developed, some of which are before us, and others we have at our factory at Lynn, Mass.

What we call the indirect, or induction, type takes current of comparatively high potential from a dynamo giving alternating currents, or from any other suitable source, such as a lighting supply line, and converts, or induces, from it a current of very low potential and great volume for electric welding, soldering, brazing, and forming of metals. One form of apparatus, which will be used for welding iron and copper wires, is here before you (fig. 1).



The "direct" type generates the currents needed directly from belt power or mechanical energy, and consists of a specially organised dynamo provided with a set of welding clamps. In fact, the needs of electric welding have given rise to a number of special and somewhat curious types of dynamos which might not otherwise ever have been invented or constructed. But one of these forms is here shown, a number of others having been designed and constructed, and others, again, are undergoing construction. Fig. 2 is an example of a type of direct-welding dynamo, similar to the one on the platform, belted to the Institute engine.

The storage battery, properly arranged, constitutes another type. It is charged from a line, or by a small dynamo kept running constantly by power. Since the welding or heavy-discharge currents are only needed at intervals, a comparatively small dynamo will usually suffice for the charging. We have used a suitable cell of

storage battery quite successfully in electric welding. Even primary batteries may, if of sufficiently low internal resistance, be used for the work, but are comparatively expensive to run.

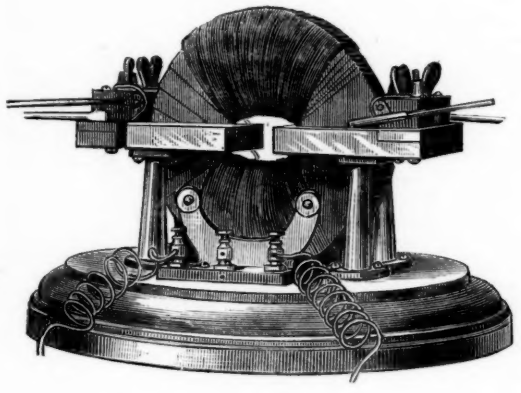


FIG 1.

Variations in the proportion and details, especially of the clamping devices, are made to suit the nature and size of the work to be done, and the shape of the pieces to be handled.

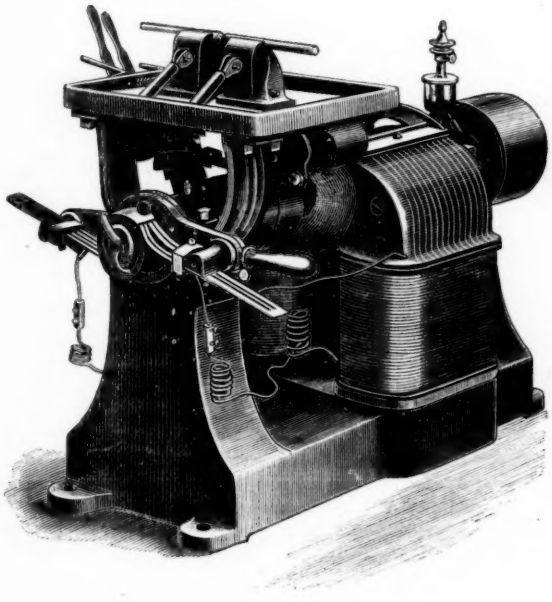


FIG. 2.

It may be mentioned that for some purposes a combined engine and dynamo for welding may come into use, especially where the work is intermittent. Thus an apparatus in all respects like a steam fire engine, but with a dynamo generating the requisite currents and substituted for the pumps, would be useful where portability is requisite and comparatively heavy work is to be done in isolated localities. The fact that the work is intermittent permits the use of less boiler capacity than would be the case were the plant to be under full load continuously.

(At this point a number of lantern slides were shown on the screen. They represented some of the various forms of apparatus which have been constructed, and their differences were pointed out.)

Prof. Thomson continued :

I call attention to the numerous examples of work done as exhibited by the specimens which are found on the two sample boards before you, and upon the table. Here is a unique specimen, a shaft with two collars, formed without any welding at all, by simply pressing it endwise by the clamps with the current put on.

Here, again, is a very curious piece, which I am sure could not be produced at all without such apparatus as is shown here. It demonstrates the rapidity with which work can be done, and the localisation of the heating effects.

The specimen referred to is one in which a bar has been put through a hole in a flat piece of wood, and burrs raised on the bar at both sides of the wood, so that the wood is held between the two expansions in the bar, and almost pinched between them. The operation was so quickly done that the heat had not time to char the wood and enlarge the hole ; or, if I may be permitted to say it, the wood had not time to find out that it should burn.

Among the specimens here shown are rings, cast iron pieces, various tools constructed by use of electric welding, chains and links, &c. The various metallic alloys, as brass, German silver, are seen, in addition to heterogeneous welds or welds of different metals one to the other.

Many persons are puzzled to know how a ring can be welded at all by the current, especially such small and thick rings as are here shown, but there is no mystery about it. The current goes by the short path in greatest amount, and so welds the ring. This is particularly true of alternating currents of rather rapid rate, and, in fact, we have organised devices which absolutely prevent more than a small fraction of the current going around the ring. To do this we have only to establish conditions such that a current going around the ring has to produce magnetism in a closed iron core, while that which does the welding is comparatively free from such necessity. In such case, self-induction and resistance are both acting together to prevent flow around the ring, instead of across the joint to be made.

Tests of tensile strength of electric welds are eminently satisfactory, and the occasion may sometime come when I can present the results, or consider for you electric welding from the standpoint of its perfection as a welding process. Its utility is, however, already established. It does very many things which no other process can do or has done.

Here is a sample of lead pipe welded without obstruction of its interior, and even without expansion outside. At a short distance away, the pipe cannot be distinguished from a plain piece, and its exterior has been left, just as it came out of the welding clamps.

Here again, is a finished axe, with the steel cutting edge welded to the body by electrical means, the welding being the last operation done before final grinding for finish.

Here is a steel rake made by electricity, and several specimens illustrating the making of carpenter's squares by electric welding.

(Prof. Thomson then explained the apparatus, which had been brought for inspection of the Institute, and showed practically the operation of electric welding.

He used both the induction coil type (fig. 1), and the direct types (fig. 2). Some of the apparatus was remarkable for its small size in relation to the size of the pieces upon which it would successfully operate. The devices for holding the pieces in place, putting on the current and giving the pressure to the pieces were shown to be very simple, and easily operated.

He also exhibited some automatic apparatus, in which the pressure given is automatic, and the current stops when the weld is completed, thus enabling the operation to be indefinitely repeated in the same way without involving skill on the part of the operator.

At the close of Prof. Thomson's remarks, a vote of thanks was tendered to the speaker for his extremely interesting presentation of the subject.)

Electric Light at Wath-on-Dearne.—Messrs. Charles Stanley and Son, who have recently erected extensive additions to their South Yorkshire Oil and Soap Works, have had the latter department lighted throughout with electric light.

A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 485.)

IV. LAWS OF MAGNETIC INDUCTION—(*Continued*).

IN our last article we found that the resistance of the magnetic circuit increased for some reason with the lines induced, and we have now to determine the law which governs this increase. The magnetic circuit furnished by the horse-shoe magnet consisted partly of iron and partly of air, but it is necessary to consider the relation between the magnetising force and the induction in the iron part and in the air part separately. We will take the former first.

Careful determinations of the relation between magnetising force and induction in different kinds of iron have been made by several experimenters. Foremost amongst these is Dr. J. Hopkinson, who employed for his experiments the apparatus sketched in fig. 39. F is a massive rectangular frame of the softest wrought iron carefully annealed. In this frame two holes, G and H, are truly bored, and through them passes the bar to be tested, C, D. The bar is turned to a gauge fitted in the holes and is in two pieces, being parted at E with the abutting surfaces scraped and lying truly on each other. A, A, are magnetising coils, and B is a test coil wound on an ivory bobbin which fits loosely on the bar. The ends of the coil, B, are twisted together and brought to a galvanometer, G. Lines of force induced in the bar pass through this test coil, which is kept in its place by D. To the coil is attached an India-rubber spring, so that if D is pulled out in the direction of the arrow the coil leaps out of the magnetic field. When a current flows through the exciting coils lines of force pass through the bar, C, D, and divide into two streams passing down on each side of the frame, the magnetic circuit thus being wholly of iron. The wrought iron frame is so massive compared with the bar to be tested that its magnetic resistance may be neglected, and the holes into which C, D fit give such a large surface contact that there may be assumed in the circuit an absence of any air space. The number of turns on A, A, is known, and by measuring the current the magnetising force in ampère turns can be at once determined. If when a current is flowing the circuit is broken, and D simultaneously

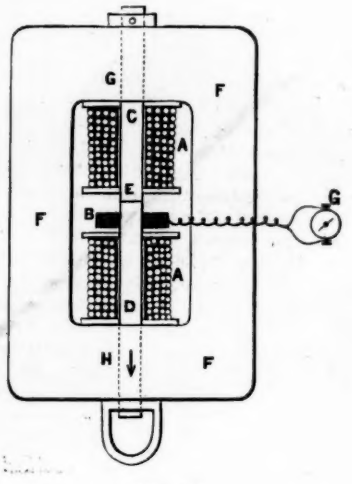


FIG. 39.

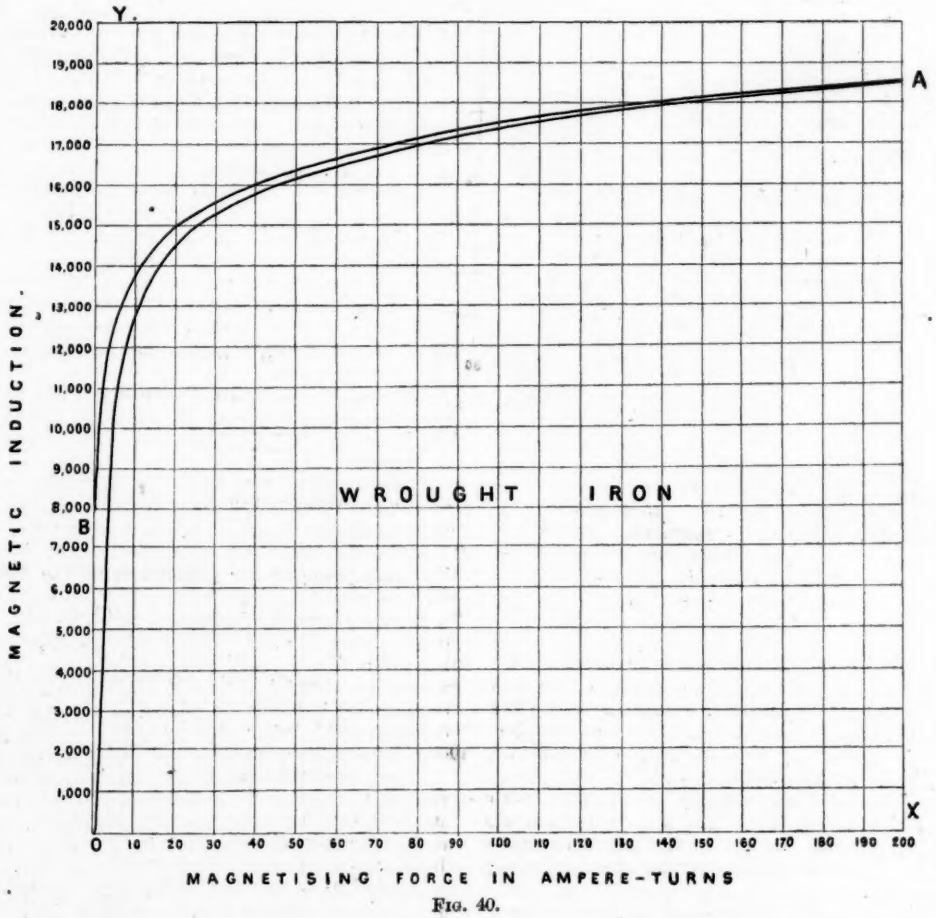


FIG. 40.

pulled out, allowing the test coil to leap out of the field, the annihilation of the lines of force running through the latter will induce a current, and a swing of the galvanometer needle will result. Hopkinson having calculated the constant of his galvanometer had here all the apparatus necessary for an absolute determination of the relation between the number of lines induced and the inducing current, and his results for annealed wrought iron are exhibited by the curves in fig. 40. Abscissæ represent the magnetising force in ampère-turns per centimetre length of the bar and ordinates the induction in C.G.S. units or the number of lines of force per square centimetre of cross section. Starting from O as the current is increased, simultaneous observations of the ammeter and galvanometer deflection are made at each step, the curve obtained being shown by the line, O A. Having reached the maximum induction, the current may be gradually decreased and observations taken as before. The line, A B, is now obtained. This curve does not coincide with the first, on account of the influence of the higher magnetising forces persisting to a certain extent when they have been diminished or even annihilated. We have still left, when the magnetising force is removed, an intensity of field represented by O B. This is termed residual magnetism, and is always manifested to a greater or less degree, however good the iron. It is impossible to get iron absolutely soft, from a magnetic point of view, or, to employ the language of the theory of magnetism given in Part I., the ultimate magnetic particles, even in the best iron, do not, when the magnetising force is removed, quite regain their formed positions. Though the difference in the ascending and descending curves is shown by the fig. to be considerable, fortunately this circumstance does not to any practical extent vitiate our calculations as applied to dynamos. It will be seen that both curves manifest the same general character, showing first a straight part then a curved part, and finally another part fairly straight.

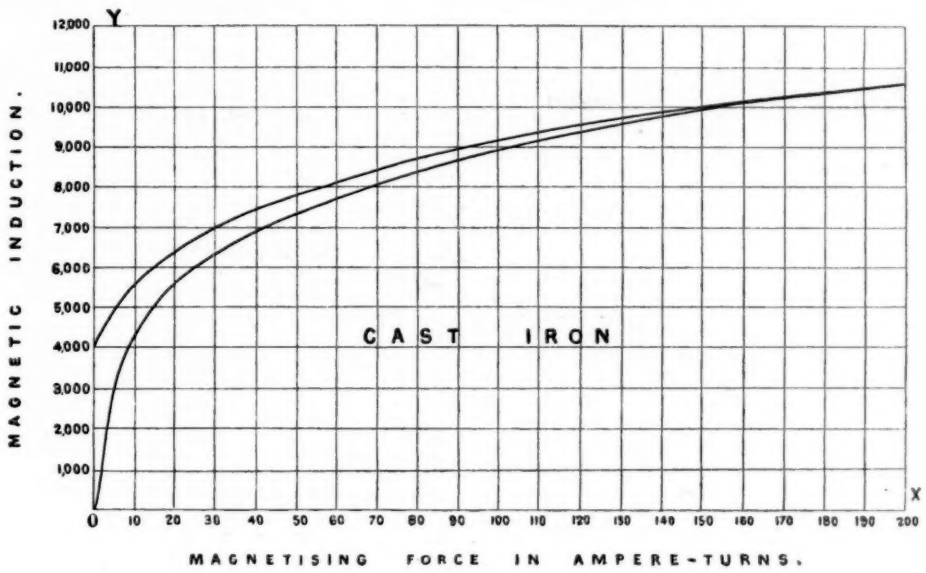


FIG. 41.

The reason for the increase of magnetic resistance with an increase in the number of lines lies, then, in the nature of the iron. With each addition to the strength of field the susceptibility of the iron to a still stronger magnetising force is diminished, and eventually we reach a field of such strength that any further addition to the magnetising force produces but small effect. When this degree of magnetisation is reached we say the magnet is *saturated*, the condition of saturation being represented by the final portion of the curve, which has only a slight rise. Hughes would probably explain this by saying that the ultimate magnetic particles of the iron are easily turned through a small angle, that the angle through which they are turned is related to the strength of the field, that their magnetic axes can never be absolutely in line, but that their resistance to turning becomes greater and greater as they become approximately so.

We see, then, from the curves that the magnetic resistance increases enormously with the induction; that, for example, the resistance at 15,000 is more than four times, and the resistance at 18,000 many times the resistance at 10,000. But the magnetic resistances of pieces of iron having similar physical properties, and having the same induction per square centimetre, have been found by experimenters to be simply proportional to their lengths divided by their cross sections. The magnetising force, as we saw in our last article, is equal to N $\mathfrak{R}$, where N is the total lines of force, and $\mathfrak{R}$ the magnetic resistance. Suppose now we have a magnetic circuit consisting wholly of iron, the induction in which is known. This circuit will have a certain resistance; but if its length is increased n times, while the induction in it remains the same, its resistance will become n times greater. The value of N, the total lines, will remain as before; but since $\mathfrak{R}$ is n times greater, A will be increased in the same ratio. If the length of the circuit remains as at first, while its cross section is increased n times, the magnetic resistance with the same induction will be $\frac{1}{n}$ of its former value. But with the same induction the total lines will be n times greater, and to produce n times the lines through $\frac{1}{n}$ the resistance requires A to have the same value as it had before the cross section was increased. Let us increase both the length and cross section of the circuit n times, or, in other words, multiply the linear dimensions by n. Here, with the same induction, the magnetic resistance is unaltered; but the total lines being increased n times, the ampère-turns have to be similarly increased. Counting the circuit with its original dimensions as the first example, we have in all four cases for consideration. In the first and third, where the lengths of the circuit are the same, we find we require the same number of ampère-turns, though, in the latter, the cross section is n times the former, and the total number of lines n times greater. In the second and fourth cases the lengths are again similar, though n times greater than in the first and third cases. The ampère-turns are also n times greater for both, though the fourth has n times the cross section and n times the total lines of the

second. The important conclusions to which these experiments lead we put in words as follows :—

(*a*) *The magnetising force required to produce a given induction per square centimetre in bars of the same quality of iron is proportional to the lengths of the bars, and is independent of their cross sections.*

(*b*) *When all the linear dimensions are increased in the same ratio, the magnetising force for similar induction is proportional to the increase.*

Let us determine now the magnetising force required to produce a given strength of field. We have to deal with bars having very different degrees of induction, and we see from fig. 40 how the magnetic resistance increases with the induction, or, in other words, how the induction falls off relatively to the magnetising force. For every degree of induction there is a particular number of ampère-turns required per centimetre length of the iron, and this number we can find directly from the curves. If we call N as before, the total number of lines passing through the magnetic circuit and a, the cross-section of the circuit, the induction is $\frac{N}{a}$, and is represented in fig. 40 by the ordinates to the curve, while the number of ampère-turns required per centimetre length for any value of the induction is given by the abscissæ. The latter is simply a function of the induction, and as a general expression for the magnetising force required we may write,

$$A = L \times f\left(\frac{N}{a}\right),$$

where L is the length in centimetres, and the function $f\left(\frac{N}{a}\right)$ is read directly off the line O X. As an example, suppose we wish to induce 300,000 lines in a piece of iron 50 centimetres in length, and having 20 square centimetres cross section. Here, $N = 300{,}000 : a = 20$; $\frac{N}{a} = 15{,}000 : f\left(\frac{N}{a}\right)$ for $15{,}000 = 25$, as measured from the ascending curve, $L = 50$, and therefore $A = 50 \times 25 = 1{,}250$. This force is required for induction in the iron alone. If the magnetic circuit consists of this piece of iron and an air space, the above will not represent the total magnetising force required, as an addition has to be made for the air space, which will be considered hereafter. On the other hand, if the circuit consists simply of this piece of iron formed into a ring without any air space the above will correctly represent the total force required for such a circuit.

In the expression given the magnetic resistance, $\mathfrak{R}$, is eliminated, and the relation between the magnetising force and the number of lines reduced to its simplest form. The use of empirical formulæ is avoided, because unnecessary and misleading. It is mere waste of time inventing formulæ to fit the curve of induction, when we have the curve itself from which we can with accuracy obtain what we require. In fig. 41 are also given curves for a specimen of cast iron tested by Hopkinson. These were obtained similarly to the others. The induction obtained by a force of 200 ampère-turns per centimetre is shown to be 10,600.

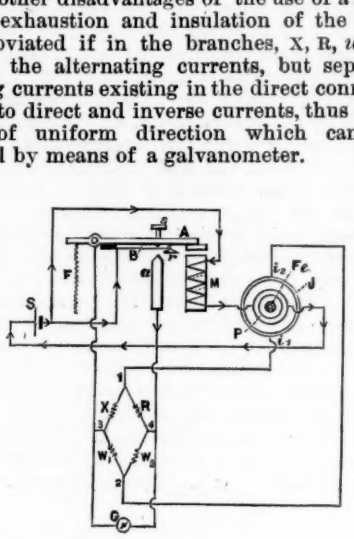
(*To be continued.*)

NEW METHOD FOR MEASURING THE RESISTANCE OF ELECTROLYTES.

By JOHANN CARL PURTHNER.

IN measuring the resistances of electrolytes the alternating currents of an induction apparatus are often used to avoid polarisation. If the Wheatstone bridge is used the absence of a current in the corresponding branch of the bridge can be shown only by means of an electro-dynamometer, or a telephone, the latter instrument being generally used for this purpose. But if this instrument is employed it is impossible to judge from its tones whether the variable resistance must be increased or diminished, and it cannot be brought to silence, which renders the measurement more difficult and involves an inaccuracy of several per cents.

But without giving up the use of alternating currents, these and other disadvantages of the use of a telephone (physical exhaustion and insulation of the observer) may be obviated if in the branches, X, R, w_1 and w_2, we retain the alternating currents, but separate any alternating currents existing in the direct connection of 3 and 4 into direct and inverse currents, thus obtaining currents of uniform direction which can be demonstrated by means of a galvanometer.



For the production of induction currents of equal intensity and duration the arrangement of Helmholtz is applied, wherein the direct currents are produced, not by interruption, but by short circuiting the primary current. In the apparatus described for separating the induction currents the spring, S, connected with one pole of the source of the primary current, S, is arranged below. The contact, *a*, is connected with the other pole, and the electro-magnet, M, as well as the primary bobbin, P, are in direct connection with the poles of the source of the primary current.

In the position of rest, when A touches the screw, *s*, the circuit is closed by the primary bobbin, P, and the electro-magnet, M, which attracts the keeper. In the downwards movement the spring, B, reaches the contact pin, *a*, short circuiting the primary current and disconnecting the bobbin, P, and the electro-magnet, M. In consequence of the counter action of the spring, F, there follows an opposite movement, removing B from *a* and re-introducing the primary bobbin and the electro-magnet.

The one end, i_1, of the induction coil, J, is in connection with 1, the other end, i_2, with 2. The alternating current therefore traverses the branches, X, R, w_1 and w_2, when X signifies the resistance to be measured, R the rheostat, and w_1 and w_2 the proportional resistances.

In order to separate any currents existing in the direct connection of 3 and 4, 3 is connected with the beam, A, and 4 with the contact pin, *a*.

When the electro-magnet attracts the keeper, and the spring, B, reaches the contact pin, *a*, whereby the direct induction currents are occasioned, any currents existing in the direct connection of 3 and 4 are short circuited by the beam and the contact column. If B withdraws from A, the induction current conductor is short circuited by the beam and the contact column, and the inverse induction currents traverse the bye-circuit, in which is the galvanometer, G.

From any deflection of the needle which is produced it may be seen whether an increase or a decrease of the variable resistance is necessary, which cannot be at once recognised, even on using an electro-dynamometer.

In measurements undertaken in the Physico-chemical Institute of the University of Vienna it appeared that by the method just described more accurate results could be obtained than by the use of a telephone, and in much less time.

In a similar manner the method of substitution may be applied in measuring the resistance of electrolytes, the decomposable conductor, and afterwards the

rheostat, being intercalated in the alternating circuit of the induction bobbin, whilst the galvanometer is in a circuit traversed only by currents of uniform direction.

In measuring the resistances of electrolytes by means of the differential galvanometer, the conduction leading from one end of the induction bobbin is divided into two branches, in one of which is introduced the electrolyte, and in the other the rheostat.

In order to obtain in each branch induction currents of uniform direction the separation of the currents in each of these two conductions must be effected separately for which purpose an apparatus described by the author in the Vienna *Zeitschrift für Elektrotechnik* (Part III., 1888) may be used.

As a matter of course the arrangement of Helmholtz can be applied as in the apparatus shown in the figuure, and the separation of the induction currents can also be effected by obtaining some of them in bye-circuits into which are inserted the coils of a differential galvanometer.—*Wiedemann's Annalen.*

NOTES.

The Paris Municipal Council and Electric Lighting.—At the last sitting of the Municipal Council of Paris, M. Binder asked several questions as to the requests which had been made for concessions for canalisation for the electric light. A list of the concessions asked for had been prepared. M. Alphand said that the papers had been remitted to the third commission. The Administration had only received demands at the end of the month of July; it was, therefore, not its fault if matters were not going on more quickly.

The authorities of the City of Paris have at last finally decided to instal at the Halles Centrales, its municipal central station for public and private lighting. This will be set up in the passage which separates the butchers' market from the tripe market. There will be six groups of machines; one for the lighting of the Halles; three for the lighting of the streets and for private lighting in Paris, and the remaining two will be held in reserve.

Royalty and the Electric Light in Brussels.—On Wednesday evening of last week some electric light experiments took place at the Northern railway station. Despite a little inequality in the distribution of the light, the result of the experiments was very satisfactory. The dynamo is installed at the bottom of the station, at the corner of the Rue de Brabant. Switches installed in different positions allow of the light being extinguished and relighted at will. After the successful results of Wednesday's experiments, the lighting of the station by electricity was officially inaugurated on Thursday at 8 o'clock. The King having intimated that he wished to honour the inauguration with his presence, His Majesty, accompanied by Lieutenant-Colonel Donny, was received in the *salon d'honneur* of the station by the Minister of Railways, Posts, and Telegraphs. Conducted by M. Godenir, the station master, and followed by the heads of the railway directorate, MM. Janssens, Belpaire, Dubois, Cutsaert, and M. Raeymaekers, head engineer, the King made a long stay in the station, observing with much interest the new installations and asking for explanations from the different gentlemen surrounding him. His Majesty then left, after having thanked the Minister of Railways, and expressed his satisfaction at the great improvement.

The Electric Light at Taunton.—The *Gas World* speaks of the arc lamps in the streets at Taunton having been out between nine and ten o'clock on a recent Sunday evening.

Bridlington and the Electric Light.—At the last meeting of the Bridlington Local Board, the Sea Wall Parade Committee reported that the idea of lighting the Parade with the electric light was for the present abandoned, it being ascertained that the requisite plant, &c., would involve an expenditure of about £600, and the working expenses afterwards would amount to pretty nearly as much as was now paid for gas. It was decided to improve the present system of lighting by laying down larger gas mains.

A Village Lighted by Electricity.—On Sunday night the village of Blockley was lighted by a powerful electric light on a mast 30 feet above the tower, making an elevation of more than 100 feet. The centre of the village is a large open space, with terraces of houses around. This was brilliantly lighted, as well as a considerable length of High Street and Lower Street. The tower was obscured by a thick fog, and from some parts the light presented the appearance of a splendid meteor suspended at a great altitude. The extreme ends of the streets are to be lighted by incandescent lamps. The church and the principal shops are lighted by electricity.

Mill Lighting.—The Gülcher Company has secured the contract for lighting Messrs. W. and J. Players's new rolling mill, Spring Hill, Birmingham, with electric light. Six 2,000 C.P. Gülcher arc lamps will be used for lighting the mill, and the dynamo and engine are being put in large enough for 10 lamps, in case it is necessary to extend the mill, in which case the balance of power will be used for running incandescent lamps. The Gülcher Company has also just completed the lighting of the Sunderland Co-operative Stores with three Gülcher arc lamps and incandescent lamps. A 3,000 C.P. lamp is placed on a bracket in front of the building for lighting the street.

Some Large Electric Lighting Installations.—One of the largest country mansions fitted with electric light is Mentmore, the seat of the Earl of Rosebery, K.G., P.C., where there are 700 lights with complete duplicate machinery, the whole having been supplied by Messrs. B. Verity and Sons. Another installation just finished by the same firm is the steam yacht *Eros*, for M. Le Baron Arthur de Rothschild, of Paris, in which case Willans engines are employed, and the interior of the yacht, which is a small palace, has some gilt and silver fittings of a most costly character. Messrs. B. Verity and Sons are also putting down for Sir John Dixon Poynder an installation similar to the Earl of Rosebery's; and at the Savoy Mansions, for Mr. D'Oyly Carte, the firm is supplying an installation for 3,000 lights, Willans engines and Siemens dynamos being used. In addition to these important works, we understand that Messrs. B. Verity and Sons are engaged upon upwards of 35 smaller installations or wiring works in progress, including the Earl of Dysart, per General Webber, Sir David Salomons, Bart., the Royal College of Surgeons, re-wiring of the Isthmian Club, Piccadilly, also Sir William McCormack's house, wiring for 1,200 lights for Lord Walsingham's Chambers in Piccadilly, Mr. Peter Robinson's private house, Mr. R. D'Oyly Carte's private house, Mr. Mather's of Messrs. Mather and Platt, and Dr. Lennox Browne's, &c.

The Bell Telephone Litigation.—The Supreme Court of the United States has decided in favour of the Government in the case of the United States *v.* the American Bell Telephone Company, brought on appeal from the decision of the Circuit Court of Massachusetts, sustaining the demurrer entered by the company to the Government suit, to cancel the patent, on the ground that it had been procured by fraud, and that Mr. Bell was not the first inventor. The Supreme Court reverses the judgment of the Circuit Court, and remands the care for trial on its merits.

The Argentine Republic and the Telegraph Convention.—The Government of the Argentine Republic has just given in its adhesion to the International Telegraph Convention of July 22nd, 1875.

Delany's Cable Transmitter.—Says the *Electrical World*: We recently described and illustrated a new system of cable transmission invented by Mr. P. B. Delany, in which Morse characters are transmitted with regularly alternating currents of uniform duration by which the signals received are clearly defined by the recorder, and hence the speed of working considerably increased. On the 9th and 16th of September, Mr. Delany's new transmitter was tried over the Anglo-American cable from Duxbury, Mass., to St. Pierre, and the results obtained seem to more than confirm the expectations of the inventor. The cable is 878 miles in length, 8,300 ohms resistance, and 256 microfarads capacity. The battery used was 23 cells of Fuller for each reversal. During the test, Mr. Delany transmitted 20 words per minute, every letter of which was received perfectly at St. Pierre, on a Morse sounder. During the latter test a Brown and Allan relay was used at the receiving end. This is by far the longest cable circuit ever worked by sound, and the speed of 20 words per minute on such a circuit is a great stride in cable telegraphy. Mr. Delany believes that he can increase the speed to 30 words per minute, and has strong hopes of working the main Atlantic cables by sound at no very distant day.

The Pacific Cable.—A Reuter's telegram says:—"The Dominion Government intends to invite the Governments of the Australasian Colonies to send delegates to Ottawa with authority to enter into negotiations for closer trade relations with Canada, and to consider the advisability of co-operation with the Dominion with a view to laying the Pacific Cable."

Electric Lighting at Exeter.—On Monday afternoon the Rev. J. G. Dangar, D.D., principal of the Exeter Training College, delivered a lecture at the Albert Memorial Museum in that city, on the "Principles of Electric Lighting." The rev. gentleman dealt with the subject in a masterly way, and his remarks were illustrated by suitable apparatus. At the close of the lecture Mr. W. H. Ellis moved the usual vote of thanks, and said that in Exeter they were still looking forward with a great deal of confidence to electric lighting being publicly carried out, and it had already been settled that many private houses were to be so lighted.

The Westinghouse System.—Up to date, the Westinghouse Electric Company has installed 119 stations, with a total generating capacity of 201,750 lamps of 16 candle-power.

Paddington and the Electric Light.—The Paddington Vestry has resolved to obtain plans and specifications to enable it to proceed with an application to Parliament for a licence to supply the electric light for public and private purposes throughout the parish.

Hexham and the Electric Light.—At the last meeting of the Hexham Local Board the following report by the lighting committee was read:—"The lighting committee have had under their consideration the recent satisfactory trials of the electric light at Allendale town, conducted by the inventor of the new chemical battery, Mr. R. P. Milburn, of Newcastle, and would recommend the board to make arrangements with Mr. Milburn to have experimental trials at Hexham of the new patent electric light." The Clerk, in reply to an observation, said that at Allendale Town they made it out to cost one halfpenny an hour. Mr. Stainthorpe: We pay twopence halfpenny an hour. The report was unanimously adopted: but just fancy, town lighting from primary batteries! Hexham will yet have to call in a consulting electrical engineer, or ask the London Chamber of Commerce for advice in the matter.

The Affairs of Emile Andreoli.—At the London Bankruptcy Court a meeting was held before Mr. Registrar Giffard for the public examination of Emile Andreoli, described as of 62, Loughborough Park. The debtor has been engaged in negotiations for Italian railways, and latterly with electrical affairs, and in 1886 started a newspaper called *L'Ingenieur Electricien*, which was published in Paris. He returns his liabilities at £3,577 15s., and assets *nil*. The debtor was not in attendance, and the examination was adjourned to December 5th.

Art Fittings.—Messrs. B. Verity and Sons are giving special attention to the designing of new and specially high class electric fittings, and an interesting display of these is to be seen at their show rooms. In an installation for Mr. Fellows, at Palace Court, Kensington, they have utilised some valuable replicas of Louis Seize "bras de lumiere" for making into electroliers with very happy effect. The firm named is also making the principal electroliers for the Glasgow Municipal Buildings, and recently completed some very high class fittings for Her Majesty's yachts *Victoria and Albert* and the *Osborne*.

Threatened Zinc Corner.—Zinc is spoken of, the *Financial News* states, as the subject of the next great syndicate. The *Cote Libre* mentions a Belgian-German combination to take charge of zinc in the same disinterested manner in which M. Secretan has dry-nursed copper. The principal producers of the metal in the Rhine district will take part in the rig.

Underground Conduit Explosion.—An explosion occurred recently at the corner of Washington and Boylston Streets, Boston, in a manhole of the Edison Illuminating Company. The manholes have an outer casing and cover of iron which withstands the loads of heavy teams, and an inner box of iron, the cover of which is held down by numerous half-inch bolts, which make a water and air-tight connection. Beneath this cover are arranged the safety catches or fusible plugs. These occasionally melt when the service wires become overloaded. The outer cover was thrown high in the air and landed on the sidewalk. A large flame and a jet of water followed. The inner cover of the manhole was alone injured. The accepted explanation, says *Modern Light and Heat*, is that sewer gas was diffused in the space around the safety catches, and by the heating of one of these the gas was ignited. In the section of the city where this occurred there is a network of sewer pipes of all varieties, and many are broken or leaky.

The Society of Telegraph Engineers and Electricians.—At the next meeting on Thursday, November 22nd, a paper will be read "On a System of Electrical Distribution" by Mr. Henry Edmunds, Member.

Cost of Electric Lighting.—A pamphlet on the present cost of electric lighting, with a brief account of modern dynamos, incandesence lamps and transformers, is being distributed by Messrs. Carey and Fricker, with the view of dispelling the prevalent impression that electric lighting is too expensive for general purposes, and that it is still commercially and scientifically in an imperfect and unsuitable state. Figures are given showing that its cost, even on a moderate scale, is less than gas, while in cases where the number of lights required is large, the balance is largely in favour of the new illuminant. It is also shown that the dynamo is now within five per cent. of the ultimate possible standard of efficiency, and that the average life of an incandescence lamp is now about 1,500 hours, and as nearly perfect as can well be desired, the conclusion arrived at being that electric lighting, whether used on a large or comparatively small scale, is the cheapest, safest and in every way the most perfect system of artificial illumination known.

The Institution of Civil Engineers.—On Tuesday last a paper was read by Mr. W. Worby Beaumont on "Friction-Brake Dynamometers." The author stated that the indications of any apparatus depending on friction must be as variable as the causes of friction and the conditions affecting it; hence the value of the measurements obtained by means of a friction-brake dynamometer must depend on the completeness with which these causes and conditions were taken into consideration or were eliminated.

The Blackpool Tramway.—Mr. J. Slater Lewis writes:—"I note Mr. Holroyd Smith has put his case into the hands of his solicitor, but up to the time of writing I have not had the pleasure of hearing from the gentleman."

Electric Lighting in Düsseldorf.—The Art School in Düsseldorf is lit up by the electric light, and the following are the reported particulars of the first complete year's run. Gas motor, 16-horse; driving hours, 635¾ hours on 199 days; glow lamps, 112; lamp hours, 52,095. Expenses:—Gas (motor) 284,450 cubic feet, at 2s. 10d., £40 5s. 7d.; gas lighting, 3,022 cubic feet at 4s. 6·4d., 13s. 9d.; gas meter hire, £1 16s.; water, 18,940 cubic feet at 3s. 4¾d., £3 4s. 9d.; water meter hire, 10s.; engine oil, 521 lbs., at 2¾d., £7 2s. 2d.; petroleum, 79·2 lbs., at 1·23d., 9s. 9d.; cotton, 13·2 lbs., at 1·13d., 1s. 6d.; wages of machinist, 895 hours, at 6d., £22 7s. 6d.; repairs and maintenance, £5 2s.; depreciation, &c., 10 per cent. on £840, £84; total, £165 13s. This corresponds to 0·762d. per 16-candle lamp per hour, or to gas (16-candle light with 5-foot burner) at 12s. 8·4d. per thousand cubic feet. The gas used was 28 cubic feet per horse-power per hour; per glow lamp per hour it was 5·46 cubic feet. Five lamps were renewed; duration exceeding 800 hours. Three short stoppages caused by the kindling aperture of the gas engine becoming blocked up. The slide was cleaned 12 times, valves inserted 10 times, and the cylinder cleaned once. In the dynamo the brushes were renewed 12 times, and the machine itself twice shifted in order to tighten the belt.

Couldn't Make it Out!—"Lawks a mercy! how that dod-gasted, insignificant, sly little whipper-snapper does git up and git with all that machinery loaded on to it," exclaimed a Western machinist the other day as he gazed in bewilderment on a Thomson-Houston motor which was driving a whole factory, a few miles from Boston.—*Modern Light and Heat.*

The Montreux Disaster.—The Paris correspondent of the *Times* states that the accident at Montreux last week was due to the telephone. The reservoir which furnished the motive power of the Chillon electric tramway being so full as to cause apprehensions, the man in charge was telephoned to in the words, "Ne mettez plus d'eau." He did not catch the first two words, and consequently turned on more water, the result being that the reservoir burst, with loss of life and great damage to property.

The Royal Society.—At the meeting yesterday, a paper was to have been read by Mr. Francis Gotch and Prof. Horsley, F.R.S., on "Observations upon the Electromotive Changes in the Mammalian Spinal Cord following Electrical Excitation of the Cortex Cerebri. Preliminary notice."

Abstraction of Documents.—A sensation has been caused in Bombay by the discovery that certain documents relating to the Bombay Electrical Company have been abstracted from the office of the Prothonotary of the High Court. In September last all the documents were safe in the Prothonotary's keeping, but on October 12th two schedules which were required for production in the Courts in the course of some litigation were found to be missing. Detectives have the matter in hand.

The Last of the Preadamites.—The Sage who attended the Washington Convention of the American Street Railway Association "to hear about horses"!—*Practical Electricity.*

The London Chamber of Commerce.—A special meeting of the Electricity Supply Companies Subsection will be held at the offices of the Chamber to-day at 3 p.m. Agenda: 1. To consider the regulations for provisional orders for electric lighting under the Board of Trade rules, and to discuss certain modifications proposed to be introduced by the Earl of Crawford, Mr. Hammond, and others. 2. To discuss the relations between electric lighting supply companies and the local authorities with which they come in contact.

An Electricity Meter.—The following letter from Messrs. Lowrie, Hall, and Kolle has just come to hand:—"In reference to Mr. Shand's remarks in the ELECTRICAL REVIEW of last week we quite agree with him, that to claim perfection for a meter so full of errors as pointed out, and invented on the other side of the water, might in this country, in the strict sense of the word, be called 'Yankee audacity.' But, as a matter of fact, full consideration has been given to any imperfections that existed, and these have been eliminated to such an extent as to be able to obtain the claimed efficiency, and not rough determinations. There are now some thousands of lights metered by this meter, where the installations vary in size from 1 to 415 lamps; the latter size, we believe, to be the largest meter on record. It was found that users of the electric light were quite sceptical as to the existence of an electricity meter when first introduced, and carefully checked the lamp-hours of burning, with a result so satisfactory that numbers of the consumers, when paying their quarterly accounts, wrote to the suppliers stating that the amount charged for exactly corresponded with their figures. The resistance that the meter offers to the flow of electricity in a circuit is inappreciable (to the eye) on the lamps, whether one or the full number is switched on. We are surprised to think that such a story about the consumer leaving his house locked up for a time should have been mentioned, as though any difficulty arises from this. Lastly, it is just as well to mention that the capacity of the secondary cells is ample for three months work, and at that time is changed when the meter reading is taken."

An Electric Tramcar in Australia.—A number of gentlemen interested in tramway locomotion, including Sir Robert Stout, ex-Premier of New Zealand, and various members of the Prahran city council, met at South Yarra a few weeks ago for the purpose of witnessing a trial of a tramcar worked by electricity. With the consent of the tramway company a car fitted up on the Julien principle was placed on the Toorak tramway line and put in motion by the electric current. The car was built by Messrs. Duncan and Fraser, of Adelaide, and was intended for the Ballarat service, but in order to test the new motive system it was fitted up by the firm specially for this experiment. With the proper complement of accumulators, the cars are calculated to run 70 miles without the supply requiring to be replenished. The car made six trips from the intersection of Chapel Street and Toorak Road to Irving Road, and up the steepest gradients it travelled at the rate of four miles an hour, and on the level at about 15 miles an hour. The visitors expressed their satisfaction with the trial.

Personal.—The *Baltimore American* contains the following announcement regarding a well-known correspondent of ours:—"Mr. William Chase Barney, accompanied by his young English wife, has returned to his native city, after an absence of nearly 40 years, and has taken apartments in the Mount Vernon Hotel. Mr. Barney is a grandson of Samuel Chase, a signer of the Declaration of Independence, and is the only living grandson of any of the signers."

The Water Primary Battery.—We read in the "New York Notes" of the *Electrical World* that "Mr. H. R. Pierson has secured the fine salesrooms on the main floor of the Telephone Building, 18, Cortlandt Street, and is fitting them up nicely to exhibit the Water Primary Battery Company's system." If our American contemporaries desire to know something of the Water primary battery we advise them to consult the files of the REVIEW from September 2nd, 1887, onwards.

Quien Sabe?—A correspondent writes:—"Has not some mistake been made in the appointments to the working committee, made by the London Chamber of Commerce? I notice the appointment among the consulting engineers of a gentleman of the name of Price. I have never heard of him as a consulting electrical engineer, nor am I aware with what work he has been connected of a character to raise him to the proud distinction now conferred upon him. I submit that Mr. Price is a consulting electrical *auctioneer*, as his name might imply, not engineer." We assume that Mr. Price was elected by the votes of the Electrical Trades Section in the same manner as his colleagues, or else he was chosen to fill one of the several vacancies caused by the resignation of members.

Lectures.—At the last meeting of Paisley Philosophical Institution, Prof. Jamieson, of the Glasgow and West of Scotland Technical College, delivered a popular lecture to a full and appreciative audience, on "What electricity has done, is doing, and is likely to do for us."

On Tuesday last week, in Owens College, Manchester, Prof. Stirling delivered a lecture on the electrical properties of the tissues, but especially of those composing the nervous system.

At Plymouth Institution, last Friday, Dr. Merrifield lectured upon atmospheric electricity.

Company Mongers.—*Money* of the 14th inst. contains the following:—"We also observed in the same list of adjudications the name of 'Oakley, Richard, High Holborn, electrical engineer.' Of course, this cannot be our old friend (?) Richard Banner Oakley, erstwhile notorious in connection with the Co-operative Deposit Bank swindle, or by whatever other high-sounding name it was known; and later, and much more recently, as manager of the Æolus Waterspray Ventilator? But why electrical? If it is the same Banner Oakley, he seems almost as versatile and ubiquitous as our other friend (?) 'Dr.' Emmens."

NEW COMPANIES REGISTERED.

Lancashire Electric and Engineering Company, Limited.—Capital £20,000 in £5 shares. Objects: To carry on at Bolton and elsewhere the business of mechanical, hydraulic and general engineers and machine makers; electricians, electrical engineers and workers and dealers in electric and other motive power and light; to construct and lay down cables, wires, lines, primary, secondary and other batteries, accumulators, mining, portable and other lamps, apparatus and works. Signatories (with one share each): *James Atherton, G. Crowther, J. Croft Sewell (electrical engineer) and F. W. Briscoe, all of Bolton; *Miles Settle, Darcy Lever; *James Tonge, Westhoughton, and *G. H. Peace, Tyldesley. Director's qualification, 10 shares. The signatories denoted by an asterisk are the first directors. Registered 8th inst. by Messrs. Waterlow Bros. and Layton, of 24 and 25, Birchin Lane, law stationers, &c.

Douglas Patent Clock and Electric Meter Company, Limited.—Capital £10,000, in £10 shares. Object:—To acquire the business of manufacturers of the patent detached pendulum and other clocks, and of meters for the measurement of electric current, now carried on by the Douglas Patent Clock Company at 93, Vyse Street, Birmingham. Signatories: *W. H. Douglas, Stourbridge; *E. L. Gyde, Handsworth; *G. W. Whitehouse, Birmingham; *T. Parker (electrical engineer), Wolverhampton; J. Moseley, Levenshulme, Manchester; H. P. Holt, Didsbury, 30 shares each; S.W. Page, Wolverhampton, 1 share. The signatories denoted by an asterisk are the first directors. Qualification: 30 shares. The company in general meeting will appoint remuneration. Registered 14th inst. by Messrs. Waterlow Brothers and Layton, of Birchin Lane, as agents for Flewker and Page, solicitors, of Lichfield Street, Wolverhampton.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Buckingham Electric Light and Power Supply Company, Limited.—The statutory return of this company, made up to the 31st ult., was filed on the 1st inst. The nominal capital is £5,000 in £1 shares. 867 shares have been taken up and the sum of 10s. per share has been called thereon. The calls paid amount to £418 15s. and unpaid to £14 15s. Registered office, Town Hall Chambers, Castle Street, Buckingham.

Automatic Electric Supply Corporation, Limited.—An agreement of 24th ult., filed on the 6th, between James Tarbottom Armstrong and Auguste Serraillier, of 9, Ducksfoot Lane, E.C. (called the vendors) and this company, provides for the purchase by the company of the letters patent No. 5,210 of 1887 for automatic apparatus for subjecting the person to the action of electric currents, and also the invention, the subject of provisional protection granted February 7th, 1888, No. 1,835, for improvements in the construction of apparatus for communicating currents of electricity to persons on the introduction of specified coins or checks. The purchase consideration is £15,500, payable by the issue to the vendors of 1,500 10 per cent. preference shares and 14,000 ordinary shares of £1 each fully paid up.

Exchange Telegraph Company, Limited.—The annual return of this company, made up to the 8th August, was filed on the 10th September. The nominal capital is £246,250, divided into 8,125 "A" and 16,500 "B" shares, of £10 each. The shares allotted are 8,125 "A" and 16,200 "B." Upon the former the sum of £8 per share has been called, the calls paid amounting to £48,000. 2,125 "A" and 16,200 "B" shares are considered as fully paid.

Dixon and Corbitt and R. S. Newall and Company, Limited (rope manufacturers, wire drawers, telegraph, telephone, and electric light cable manufacturers).—The annual return of this company, made up to the 5th October, was filed on the 16th October. The nominal capital is £120,000, divided into 6,000 ordinary and 6,000 5 per cent. preference shares, of £10 each. The whole of the ordinary and 1,757 of the preference shares are taken up, and upon the former the full amount has been called, and £8 per share upon the latter. 6,000 ordinary and 200 preference shares are considered as fully paid up. The calls paid amount to £12,400, and unpaid to £56.

Humboldt Electric Power and Mining Company, Limited.—The registered office of this company is at 63 and 64, New Broad Street, E.C.

Manlove, Alliott and Company, Limited.—The registered office of this company is at the Bloomsgrove Works, Radford, Nottingham.

CITY NOTES, REPORTS, MEETINGS, &c.

West India and Panama Telegraph Company, Limited.

THE twenty-third half-yearly ordinary general meeting of this company was held at Winchester House on Wednesday, under the presidency of Mr. C. W. Earle, chairman of the company.

Mr. R. T. Brown, the Secretary, having read the notice convening the meeting,

The Chairman, in proposing the adoption of the report, said that meeting was marked by one circumstance which made it a somewhat exceptional meeting. It was the first time in the twenty years the company had been in existence that they had ever met with every one of their cables in working order. They had a good many sections which were very subject in that capricious field to interruption. He did not wish them to regard the fact of their present exemption as too good an augury, although he believed the system was stronger and in better condition than it had ever been in before; still, knowing what he did of these matters, he did not wish to lead them to suppose that the halycon days of absolute freedom from those disasters which were so costly to them were likely to arrive. In fact, he might tell them that since the report was written they had had one interruption. It was smartly repaired, however, by the *Duchess of Marlborough*, and he merely mentioned it to show that even whilst they were there the satisfactory state of things of which they were speaking might be modified. With regard to the accounts, it was satisfactory to know that there was a small increase in the traffic revenue of the company. On the debit side of the accounts there was very little indeed to remark upon. There was a slight increase in the salaries and wages, which was entirely accounted for by the promotions which they thought it just and politic from time to time to give to the servants of the company, whose experience and length of service warranted a little encouragement. A hopeless service would be a dead service, and he thought the few pounds they laid out in thus encouraging the staff—and they did it, he was sorry to say, with a very close hand—were well spent. The chief increase on the expenditure side of the account was owing to the expenses for repairs of cables, which amounted to £2,241 in excess of those for the corresponding half-year. That increase was entirely accounted for by the extra length of cable which they were obliged to put in in the course of sundry repairs executed during the half-year; and that expenditure was not without its compensating influence upon the account, because it went to diminish the contribution they would otherwise have had to put to the reserve fund. Of course, the reserve fund of telegraph companies was principally a depreciation fund to be used for the renewal of the cables as they failed, and if they put in a considerable portion of new cable, that went towards the purpose for which the reserve fund was created. If the reserve fund was up to the calculated depreciation for the moment it exonerated them from putting aside the sum they otherwise would as a contribution to the reserve fund. The policy of keeping up the reserve fund had often been criticised in that room, but he thought he might claim that the present position of the shares of the company, in comparison with what they were in the olden times, was due very much to the existence of the reserve fund. He hoped that meeting would endorse the policy of the board, and encourage the directors to keep up that which was the mainstay of the system and the basis of what little prosperity they now had. There was, he was sorry to say, a growing feeling amongst governments in the West Indies against long continuation of their subsidies. They were now voted annually; formerly they were voted for 10 years. It was an unfortunate policy, both for the governments and for the company; for the company, because it gave them no security of tenure, the absence of which tended to restrict their operations. There was no encouragement for them to duplicate a weak cable whilst subsidies were only a matter of annual vote. There was also another cause of anxiety about their position in the West Indies, and that was the renewal of the French competition. Since they last met in that room a new cable had been laid by a French company, going from Venezuela to San Domingo, Java and Cuba. At present it interfered very little with their traffic, and he had not a word to say against their keeping that position. But they knew that in the articles of association, or the statutes, of the French company, was the clause that the company was formed to promote the development of French telegraphy, and they were not without some anticipations that they might eventually make extensions into the territory of the West India Company. He believed that they were acting in contravention of their own concession by occupying the ground they now had; he was quite sure they were acting in contravention of the Spanish concessions to the West India Company. Therefore the directors had felt it their duty to call the attention of the Spanish Government to the matter. They had no wish to act the part of the dog in the manger: they did not object to the French Company going to Venezuela, if they did not go there themselves. But they would object very strongly to their taking cables into this company's stations. Not one of those stations could afford to support another company. Competition, therefore, would be disastrous to both parties. He moved that the directors' report and accounts be received and adopted, and that a payment of 12s. per share on account of arrears of dividend on the first preference shares, be declared.

Mr. William Ford seconded.

Mr. Odell put one or two questions relating to the accounts, which were explained by the Chairman, and further asked why the board did not pay a small dividend on the ordinary shares, as they could well afford to do, drawing from the reserve. He had been a shareholder for many years and had only received two small payments as dividend.

A Shareholder asked whether the reason why the Governments now only granted the subsidies annually was that the cables were frequently interrupted.

The Chairman said that was not the case. The change was due to the constant idea that somebody was going to bring a cable to their islands, and they did not wish to be tied to this company. The amount of the subsidy was £24,000 a year, if it was all paid, but deductions were made for interruptions and other things. With regard to the payment of dividend out of the reserve, it was opposed to their policy to trench on the reserve fund, which it was their duty to keep up to the present amount.

The resolution was carried unanimously, and the proceedings terminated, after a vote of thanks had been accorded to the chairman.

The Australasian Electric Light, Power, and Storage Company, Limited.

THE ordinary general meeting of this company was held at the offices, 41, Coleman Street, E.C., on Monday, Mr. B. H. Van Tromp presiding.

Mr. J. H. Duncan, the Secretary, having read the notice convening the meeting,

The Chairman said: Gentlemen, in rising to move the adoption of the report and accounts, I think it will only be necessary to trouble you with a very few observations. You will remember that on the last occasion we met I told you that we had already then made new arrangements with regard to the expenses in Australia and in London. These new arrangements, however, came into operation for about two months of the year 1887, and it is therefore in future years that we shall derive the benefit of these new arrangements. On looking at the accounts now submitted it will be seen that there is a loss on the working down to the 31st December last. I think it was pretty well understood at the meeting held in October that there would be a loss, but we have great hope that in the future we shall so be able to keep down expenses as to prevent the possibility of a loss, and I trust indeed that when we meet you this time next year we shall be able to bring before you such a statement of the progress made in Australia as will give you renewed confidence in your board, so that you will continue to believe that we are perfectly honest in our endeavours to do the best we can for this company. At the close of the meeting last year, when you were good enough to pass a resolution of confidence in the board, I then pledged myself if the company went on that we would do our utmost to bring it into a dividend paying condition. Well, the efforts of this year have been mainly devoted to the securing of the contract with Melbourne for the lighting of the Exhibition, a work larger than any that has been entered into, and more important than any single installation of a temporary character that has ever before been made in the whole world; and when I tell you that this work has been carried through chiefly by means of cable messages to Australia, requiring daily watchfulness, the exercise of the utmost care and attention in giving directions to our representatives in Australia, so that we might be able to secure the contract without the possibility of a loss, you will understand the attention we have given to your interests. At this period of my observations I desire to say, and I wish it to be placed on record, that Captain Rohan, our able manager in Australia, made efforts of an almost supreme character to get this contract, and we secured that contract against a large number of competitors. The American party was there, the German and the Hungarian parties, but we have succeeded in obtaining that contract, and I am glad to be able to assure you that so far as the present position will enable us to say we shall receive on this side a net profit of at least £4,500 to £5,000 out of that contract alone. I think this is a result which may be mentioned with some degree of satisfaction by the board, and I do hope that the shareholders will give us credit for having taken a great deal of trouble, and devoted an immense amount of time to the securing of such an arrangement as that. Then in addition to the profit we are going to make out of the transaction, it greatly enhances our position in Australia, and gives the electric lighting industry such a start as it could never have otherwise secured. The official report of the Exhibition Commission shows the satisfactory way in which the contract has been carried out by the company. Then it is a great satisfaction for us to inform you, and it will be an even greater satisfaction for you to know, that there will be no penalties incurred in this case. We were ready with our installation on the date stipulated, although we had only two months allowed us in which to prepare and send out an enormous plant costing nearly £20,000. You may possibly wonder how this was accomplished without money, for if you refer to the accounts rendered last year you will see that the company possessed in this country an amount of uncalled capital of about £11,000 to £12,000, upon which there already existed a loan of £5,000, so that all the credit we had was about £6,000, which if we had called up would have exhausted the whole of the company's resources. The directors thought it better not to make the final call, and by giving personal guarantees we entered into a very satisfactory arrangement with the Anglo-American Brush Company, who supplied the plant, and we are paying them off rapidly as our remittances have come from Australia. When I repeat that this has been done without asking you gentlemen for a single shilling, it shows that the directors have the confidence of financiers in London who believe that we should not enter into engagements which we could not fully and thoroughly

carry out. Gentlemen, you have the accounts for 1887 before you; you can read them as well as I can, and I do not intend to dwell on the figures at any length; but I venture to ask your special attention to the items for 1886 as compared with those for 1887, and you will see that in nearly every instance, except in the item for cablegrams, there has been a reduction; so that it is evident, if we had not practised a rigid economy, the loss for 1887 would have been greater than it is. I told you last year that we were having a very voluminous correspondence with Captain Rohan on the question of reorganisation. I need not tell you that at this distance from Australia it is most difficult to conduct these things by correspondence, and in our negotiations with the agents and correspondence with Captain Rohan it happened that somehow or other the business of the company was a little lost sight of, and hence the sales were not so large, nor the returns so great, as I believe they will be in future. We have a great field of work before us—India, Queensland, New Zealand; there is only one thing wanted to enable us to make, I believe, a tremendous success, and that is the capital. Three-fourths of our capital was gone before we spent a single sixpence in work that was to bring us in any return. We have only the small amount I have named uncalled, and although the matter has not been formally settled, we believe that if we could raise some £15,000 or £20,000 on preference share, carrying a preferential dividend of 5 or 6 or 7 per cent., this money to be used for the one purpose of erecting a magnificent lighting station in a large town like Bombay or Calcutta, or at Sydney, Adelaide, and other large towns of Australia, a large and handsome return could be made. I need hardly say that we court the fullest enquiry. I have always regarded a board as the servants of the shareholders, and not as some seem to think their masters. We want to take you in counsel, and get your advice and obtain your assistance. We have a good thing in this company, and I believe there is a great future for us. With regard to the Melbourne Company, we hold about one-third of its capital; that company is carrying on a considerable business. Electric lighting is extending, the company has made new contracts with large wholesale houses, and they are gradually extending the field of their operations. But they are doing more than this; they are endeavouring to bring into their circle a body of gentlemen who will find money for still further extending the business of electric lighting. I am informed that negotiations are going on with a rich and powerful syndicate in Melbourne by which our company there is to be merged with the larger undertaking, and you may depend upon it that we intend to get a very handsome *quid pro quo* for anything we part with by way of plant, goodwill, or otherwise. The lighting of the Melbourne Exhibition being such a great success, has excited the attention of everybody on that side of the world, and I believe that ultimately yet we shall gain a great success. The shareholders in this company have been very kind, and we look to the shareholders for their assistance in the future. Throughout the whole world a great movement in favour of the electric light is springing up. The Edison company proposes to increase its capital in order to erect two new lighting stations in Berlin, where it does not intend to leave a single street unlighted by the electric light. It is said that every large arc light in New York is equal to one policeman. I am a director of a large hotel—the Grand Hotel, Brighton—and we are going to establish the electric light throughout that establishment without increasing the cost of lighting to the company. But I need not dilate on the advantages of electric lighting. The demand for it is bound to increase. In Australia, where gas is dear and money plentiful, the chances of electric lighting are particularly favourable, and with the assistance and support of the shareholders, we hope to show a different result to our operations in the future. With regard to the raising of fresh capital, I put it to you whether it would not be desirable that two or three shareholders acquainted with electrical matters should confer with the board on the question. We are carrying on the company with such a small amount of money behind us, that we are afraid to go into large contracts. I beg to move the adoption of the report and accounts.

Mr. Guesdon seconded the resolution. He approved of the proposition to raise fresh capital on preference shares, and would gladly subscribe his share of whatever might be issued. He trusted that shareholders generally would do so, and give the company a fair chance of success.

Mr. Morrison thought that the preference shares should carry, say 10 per cent. interest, in order to ensure the success of such an issue.

Mr. Ince also concurred in the suggestion of raising money by the issue of preference shares for the purpose of erecting a central station. He thought that perhaps India would be a better base than any other.

Mr. Kisch wished to know whether the Melbourne Exhibition plant would be taken back by the company after the close of the Exhibition, or whether it was sold outright.

The Chairman: It is absolutely sold with regard to nearly the whole of the £32,000 worth.

Col. Wilkinson wished to know if the profit on the Melbourne lighting was assured profit.

The Chairman: Yes, it is; about 90 per cent. has now been received.

The report and accounts were unanimously adopted.

The re-election of the auditors was unanimously carried, after which Messrs. Van Tromp and Sanderson were re-elected directors.

A vote of thanks to the chairman and directors terminated the proceedings.

The Schanschieff Electric Battery Syndicate, Limited.

THE first annual report of this company states:—"This company was originally formed to acquire Mr. Schanschieff's patent rights for his inventions, to perfect the same, acquire further patents in foreign countries, and thereafter to re-sell the patents or to work the same. After much experimenting work had been done demonstrating the value of the invention, this company agreed to sell on certain terms to another company called "The Schanschieff Electric Light and Power Company, Limited," which company was duly promoted and formed. Litigation, however, having arisen as to the validity of the patents, and exception having also been taken as to the price to be paid, the directors of the new company desired to be released from the contract, and the shareholders of this company authorised the cancellation of the same, which was done.

"In the meantime, however, this company, believing the objects of its formation accomplished, had resolved upon voluntary liquidation, and application had therefore to be made to the court to stay the winding up, which was granted.

"It is needless to remark that the above-mentioned operations, besides costing the directors a vast amount of work and time, were very expensive—all the items of which appear in the accounts. The expenses of development although not added to the cost of the patents in the accounts, properly belong thereto, and will be added to the same in the next balance sheet when the true value of the patents by sales, &c., is demonstrated.

"Upon the staying of the liquidation proceedings, the company was virtually without funds; the limited capital originally raised having been nearly all expended over the above-mentioned items as detailed in the balance sheet; it was therefore resolved to further increase the capital to the extent of £10,000 by the issue of 40 additional shares. The larger portion of this capital taken up (£6,500) was subscribed by a few shareholders only.

"The sale of the Australian patent has now been completed on terms.

"The litigation is now also at an end, and the competing patents of Mr. Barber-Starkey have been acquired by this company, and you now have the benefit of both patents.

"By the accounts it will be seen that, besides the shares representing £3,500 unissued, there is cash on hand nearly £7,000 and plant to the value of about £2,500.

"The directors regret to report losing the services as director of Mr. David Marks, who has resigned, owing to his visit to Australia. They hope soon to see him back again at the board.

"Mr. Sigmond Hoffnung and Mr. F. H. Harvey-Samuel joined the board on the re-formation of the company after the liquidation preceedings had been stayed. Your directors are now actively engaged in developing the business, and anticipate a good future for the company.

"BALANCE SHEET, 29th September, 1888.—DR.—To capital:—£40,000 in 160 shares £250 each. Issued 146 shares at £250 each, £36,500; less calls unpaid, £361 — £36,139; sundry creditors, £933 17s. 9d.—Total, £37,072 17s. 9d. CR.—By cash at bank, £6,905 19s. 10d.; sundry debtors, £231 1s. 10d.; stores in hand, plant, machines, &c., tools, gas fittings, centre and hydraulic lifts, fitting up premises, offices, &c., office furniture—£2,425 14s. 2d.; patents—£20,525 9s.; costs of experimenting, trials, &c. (£1,881 2s. 11d.); general expenses, salaries, rent, &c. (2,442 11s. 7d.); expenses promoting 'The Schanschieff Electric Light and Power Company, Limited' (£2,249 6s. 8d.); legal expenses (£306 11s. 9d.); liquidators' fees, in respect of liquidation of this syndicate, afterwards set aside (£105), £6,984 12s. 11d.—Total, £37,072 17s. 9d.

"Examined with the vouchers and books of account of the Syndicate, and found in conformity therewith. The directors, however, have minuted a sale of the Australian patents for £40,000, payable in cash and shares of a company there, which contract will be subject to the original agreement with Mr. Schanschieff; and also a purchase of the Barber-Starkey patents for the sum of £2,000, in respect of which sale and purchase no payment has yet been received or made, and which sale and purchase are not entered in the account books of the company to the 29th September last.

"RICHARD RABBIDGE, F.C.A.

"32, Poultry, E.C., *November 1st*, 1888."

[The first annual meeting of the company was held on Tuesday afternoon. A notice of the meeting had been forwarded to us, together with an intimation that the presence of our representative would be welcome. When our reporter attended the meeting, however, he was requested by the Chairman to withdraw. We are therefore unable to give a report of the proceedings.—EDS. ELEC. REV.]

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 9th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,728.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st October are £2,715, as compared with £2,803 in the corresponding period of 1887.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending November 9th, amounted to £5,782.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending October 31st are £6,000.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

A SPECIAL general meeting of this Society, of Members only, was held on the 8th instant, at which resolutions were passed approving of the change of title to that of The Institution of Electrical Engineers, and abolishing the office of Honorary Secretary. These resolutions to become legal, are to be submitted for confirmation at a special general meeting to be held on the 22nd instant.

Later, an ordinary general meeting was held, at which it was announced that a lithographic portrait of the late President, Sir Charles Bright, had been presented to the Society by Lady Bright.

A paper was read by Mr. W. Lant Carpenter, B.A., on "Ocean Temperature in relation to Submarine Cables," of which an abstract was given in the ELECTRICAL REVIEW of the 9th inst. The discussion was opened by

Mr. ALEXANDER SIEMENS, who gave some illustrations of ocean temperatures based upon practical observations which were made on the Commercial Cable Company's cable between Waterville and Weston-super-mare, 320 knots in length. The results were plotted out on three diagrams which were exhibited. The observations extended over the years 1886, 1887, and 1888, the curves were almost identical, according to the period of the year, and showed that the variation in the resistance of the conductor was indicated inversely by the variation in resistance of the dielectric. At a distance of 120 miles from the Irish end the actual temperature of the sea was 52° F., whereas the resistance of the cable showed 56° F., a discrepancy which served to show that the shallow waters of the Channel had a great influence and varied more during the year in their temperature than deeper waters. The greatest depth at which the cable was laid was 100 fathoms.

Mr. STALLIBRASS advocated the use of electrical thermometers as possessing great advantages over others, and being less liable to the false moving of the indices. He suggested the introduction of a correction table.

Capt. WHARTON, hydrographer to the Admiralty, had little to remark that was strictly germane to the subject as regards submarine cables, but compared the various thermometers used by the Admiralty, and said that the Siemens sounding instrument was very valuable when in the hands of competent persons.

Mr. CHARLES BRIGHT pointed out that not only did different insulators vary by temperature, but that the mixtures of those materials each had a distinct variation, and it would be necessary to have a formula for the coefficient of each. [Further remarks from Mr. Bright may be found in our other pages.]

Dr. OBACH related experiments he had made to find out what influence pressure had on thermometer readings, and said that with a pressure of two atmospheres there was a difference of one-fourth to one-third of a degree centigrade.

Mr. REDGRAVE, as one who had been upon many cable expeditions, was glad to hear Mr. Carpenter's explanation of the cold wave round the coast near Halifax, as it explained the very low temperature of 29·5° F. which tests of the cable indicated.

After a few remarks by Mr. MORDEY,

Mr. LANT CARPENTER briefly replied, and pointed out that the diagrams explained by Mr. A. Siemens were for comparatively shallow water which might be affected by the temperature of the air above it. Observations in the *Challenger* expedition showed that the superheating effect of the sun's rays did not reach more than 100 fathoms.

After a vote of thanks to Mr. Carpenter, the meeting adjourned until November 22nd, when a paper will be read by Mr. H. Edmunds "On a System of Electrical Distribution."

Physical Society, November 10th.

Prof. REINOLD, President, in the Chair.

THE following communications were read:

"On the Calculation of the Coefficient of Mutual Induction of a Helix and Coaxial Circle," by Prof. J. V. JONES. In arranging some experiments for determining resistance absolutely by Lorenz's method, the author had occasion to consider what form of standard coil was most suitable for accurate calculation, and chose a helix of large diameter with a single layer of wire. To obtain a sufficient number of turns requires considerable axial length, and Lord Rayleigh's approximate method of calculating the coefficient was found to be insufficient where an accuracy of $\frac{1}{1000}$th per cent. is required. A method of calculation is given considering the wire as a helix whose equations are $y^1 = A \cos \theta^1$, $z^1 = A \sin \theta^1$, and $x^1 = k\,\theta$, those of the circle being $y = a \cos \theta$ and $z = a \sin \theta$.

The general expression for M, viz., $\iint \frac{\cos c}{r}\, d\,\theta\, d\,\theta^1$, when applied to this case, becomes

$$M = \int_0^{2\pi} \int_0^{\theta} \frac{A\,a \cos(\theta^1 - \theta)\, d\,\theta\, d\,\theta^1}{\sqrt{A^2 + a^2 - 2\,A\,a \cos(\theta - \theta^1) + k^2\,\theta^{1\,2}}}$$

One integration is performed by change of variables, making $\theta - \theta^1 = \phi^1$ and $\theta^1 = \phi$. When θ is an integral multiple of π (say n) the integral is expressible in terms of a series, involving the complete elliptic integrals, E and F, of modulus $c = \frac{2\sqrt{A\,a}}{A + a}$, the expression for M being

$$M = 4\,n\,\pi \frac{A\,a}{A + a} \Sigma (-1)^m \frac{1 \cdot 3 \ldots 2m-1}{2 \cdot 4 \ldots 2m} \frac{1}{2m+1} \left(\frac{x}{A+a}\right)^{2m} P_m$$

where

$$x = h\,n\,\pi \text{ and } P_m = \int_0^{\frac{\pi}{2}} \frac{\cos 2\,\theta\, d\,\theta}{(1 - c^2 \sin^2\theta)^{\frac{2m+1}{2}}}$$

If

$$Q_m = \int_0^{\frac{\pi}{2}} \frac{d\,\theta}{(1 - c^2 \sin^2\theta)^{\frac{2m+1}{2}}}$$

then

$$P_m = \left(1 - \frac{2}{c^2}\right) Q_m + \frac{2}{c^2} Q_{m-1}$$

and

$$Q_m = Q_{m-1} + \frac{c}{2m-1} \frac{d}{d\,c} Q_{m-1}$$

observing that $Q_0 = F(c)$ and $Q_{-1} = E(c)$, P_1, P_2, &c., may be expressed in terms of F (c), E (c) and c.

Instead of calculating each term P_m independently, it is found easier in practice to deduce successive values from equation (B) and (C) combined with $(1 - c^2)\,Q_1 = E$ and its derivatives. Applying the formula to a circle of 10 inches diameter placed concentric with a helix of 20 inches diameter and 4 inches long, the value obtained is $M = n \,.\, 53{\cdot}259$, whereas Lord Rayleigh's formula gives $n \,.\, 53{\cdot}317$.

Prof. PERRY asked if the thickness of the wire had been considered, and whether the author could give any information as to practical working formulæ for the mutual induction between two ordinary cylindrical coils in any position.

Dr. FLEMING described a wooden anchor ring wound like a Gramme armature, and having a secondary coil added, which he had devised as a standard of mutual induction, and used for determining capacity absolutely.

In reply, the AUTHOR said he had not considered the wire to have thickness, as he felt sure this would not affect the result for his coil, by one part in 100,000. With respect to Dr. Fleming's anchor ring, he considered the difficulty of winding it sufficiently uniformly to be a great drawback to its general adoption.

"On a New Form of Standard Resistance Coil," by Dr. J. A. FLEMING. Considerable difficulty has been experienced with coils of the ordinary B.A. construction when immersed in water or melting ice, due to leakage across the paraffin wax, caused by condensation of moisture. To overcome this, various forms have been tried, and the best yet devised is made by winding the coil in the space between two shallow annular rings screwed together by projecting flanges. The joint is formed by India-rubber, and can be tested for leakage by immersing in water and applying air pressure through a small testing tube. The rising part of the terminal rods are enclosed in long brass tubes soldered to the upper casing, and insulated by air, excepting at the top and bottom, where ebonite rings are placed. The top ring forms a corrugated cap, and an annular channel in its upper surface serves as a fluid insulator. The wire, which is triple silk covered, is best baked for some hours at a temperature above 100° C., and then soaked in anhydrous paraffin wax containing about 3 per cent. of resin.

LEGAL.

Re the Faure Electric Accumulator Company, Limited.—Chancery Division, November 13th.—(Before Mr. Justice Kay.)—A question arose in this case upon which hitherto there has been no decision—namely, whether brokerage paid by a company to a third person in consideration of his placing the shares of the company was a lawful payment or not. On May 23rd, 1882, Mr. F. A. Pinkoffs, a stockbroker, offered to place 7,500 £10 shares of the company, the company to pay him 2s. 6d. per share, and to give an option to the person to whom the 7,500 shares were allotted to take up 12,372 more. The directors accepted the offer, and the 7,500 shares and the 12,372 shares were allotted by means of Pinkoffs to Mr. William Morris, a stockbroker. The company was registered on February 15th, 1882, for the purpose of purchasing and working certain patents for the storage of electricity, the invention of a Mr. Faure. The capital of the Faure Company was £1,000,000, divided into 80,000 shares of £10 each and 200,000 shares of £1 each. On June 19th, 1884, the company went into voluntary liquidation, and subsequently the liquidation was continued under the supervision of the Court. This was a summons taken out by the liquidators of the company, under section 165 of the Companies Act, 1862, asking—(1) For a declaration that M. Simon Philippart, Sir Arthur Otway, Sir Charles Clifford, Charles Seymour Grenfell, Harvey Ranking, and Edward Ponsonby, the first directors of the company, had committed a breach of trust in allotting 19,872 shares to one William Morris, a nominee of Philippart's, or alternatively for allowing 18,500 of such shares to be transferred by Morris to Philippart, with the knowledge that Philippart would be unable to pay the £8 per share then remaining uncalled thereon. (2) For a declaration that the directors were in any event jointly and severally liable to make good to the assets of the company the sum of £2,485 5s., the brokerage paid on the 19,872 shares to Mr. Pinkoffs. The summons was dismissed as to M Philippart, by consent, he paying his own costs,

and Mr. Edward Ponsonby was relieved of such costs as were incurred before he joined the board. Sir Horace Davey, Q.C., and Mr. Grosvenor Woods appeared for the liquidator; Mr. Ince, Q.C., Mr. Buckley, Q.C., and Mr. Woodroffe appeared for the directors; Mr. J. Henderson and Mr. Merrick appeared for Philippart. Mr. Justice Kay said that in the entire absence of corrupt or dishonest dealing, it was out of the question that he could make the directors personally liable for the allotment and transfers of the shares. Mr. Morris was a stockbroker in a large way of business, and the directors at the time they sanctioned the transfer to Philippart honestly believed that Philippart was a proper transferee. This part of the summons then would be dismissed with costs. As to the payment of brokerage, the practice had grown up out of the launching of bubble companies, and was one to be discouraged. This payment of brokerage was a mode of issuing shares at a discount; the objection to such payments was that they partook of the nature of a bribe. In his lordship's opinion the payment of 2s. 6d. to Pinkoffs on every share allotted to Morris was ultra vires, and the directors were jointly and severally liable to repay the brokerage with 4 per cent. interest. This part of the summons, therefore, would be allowed with costs.

COMPOUND-WINDING PATENTS.

ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION *v.* ORIENT STEAM NAVIGATION COMPANY.

THIS action for infringement of patent No. 2,003 of 1878 came before Mr. Justice Chitty, in the Chancery Division of the High Court of Justice, on Tuesday.

Mr. J. Fletcher Moulton, Q.C., Mr. Romer, Q.C., and Mr. Graham appeared for the plaintiffs; and Mr. Byrne, Q.C., for the defendants.

Mr. MOULTON said the action was one for the infringement of a patent for various improvements in the dynamo-electric machine. The patent was taken out by Mr. Haddan, a patent agent, as a communication from America; the original American patent was by one of the best known electricians of America, Mr. Charles F. Brush, and the patent included claims for various matters, including an electric lamp, which had since been abandoned. There had been one or two disclaimers, and the patent was cut down to six or seven claims.

Mr. JUSTICE CHITTY: What are the issues, Mr. Moulton?

Mr. MOULTON: Everything, as usual, is in issue. What is proposed to be fought I don't know.

Mr. JUSTICE CHITTY: They were very anxious not to try the case, were they not? There was something said about a Scotch action.

Mr. MOULTON: Yes, my lord. I propose to open as shortly as possible, consistent with putting your lordship in possession of the one point which is being fought, and then call my witnesses and be guided by my learned friend's cross-examination.

Mr. BYRNE: I do not propose to cross-examine, and I am not in a position to call any witnesses. But I do not propose to offer my learned friend any assistance in proving his case.

Mr. MOULTON, continuing, said he would put very shortly the real point of the invention in the case, and he could do so without reference to the specification in the first instance, because he did not think there could be any question whatever but that the specification claimed in the very clearest form the particular invention which he would describe. The dynamo machine was simply a method of obtaining currents of electricity from another form of energy—namely, motive power. All acted in the same way. Coils of wire were rotated immediately in front of or close to a magnet, and when so rotated, according to the great discovery of Faraday, electric currents were started in the wire. Those currents were collected and carried off into the circuit which supplied the lamps. That was the general scheme of the physiology, if he might so put it, of the dynamo machine. The first idea was to make a magnet, as strong as they could, of steel, rubbing it with a lodestone or with another magnet, and to revolve the coils near a magnet so constructed. But the strength of the steel magnet was quite trifling when compared with a magnet which could be made by means of a current of electricity itself; that was to say, by wrapping wire round a piece of soft iron and sending a current through the wire, the soft iron core would be converted into a very powerful magnet, beside which the steel magnet was a very puny thing. In dynamo machines the intensity of the magnetic field was of very great importance, because the amount of electricity obtained was directly determined by the strength of the field, so people began to use electromagnets instead of steel magnets in the presence of which to revolve their coils. Then a most brilliant idea struck somebody: it struck three people, as near as could be told; at any rate, he believed it was announced on the same day by three people. It was this: a dynamo machine produces a strong electric current; it makes it very much stronger if it has a strong magnet; so that it occurred to them to wind the wire which came from the dynamo machine round the magnets of the dynamo itself. The consequence was that if these magnets had any magnetism to start with—and it was discovered that they always kept enough magnetism to start with—the revolving of the coils in front of these weak magnets set up a slight current; that passed round the magnets before going to the lamps, thus making the magnets stronger; which in turn greatly increased the current which went to light the lamps, so that the strength of the magnetic field grew in a few seconds to most enormous proportions, without any elaborate apparatus for getting an independent current. [A diagram illustrating the simple form of dynamo described was handed to his lordship.] This was a very admirable form of dynamo, but there was one great defect in it. Supposing some obstacle, some extra resistance, was offered to the current in the external circuit, that would weaken the current instantly, the magnetic field would become weaker, and just when most power was required to overcome the extra resistance, the very presence of the resistance took away the strength of the machine. Thus the machine was very sensitive to any changes of resistance. That form of machine as shown by the diagram was called the series, because the magnets and the lamps were in series one with the other. To overcome this, the shunt form of machine was devised. [A second diagram was here handed to the judge.] There the circuit was shown going round the horse-shoe magnets, making them very powerful magnets, as an alternative path to the external circuit. In the first case all the current went round the magnets and went to the lamps; in this case, part of the current only went round the magnets. Electricity divided itself, if it had two alternative paths, according to the difficulties. If one path was ten times as difficult as another, only $\frac{1}{11}$th of the current would go through the more difficult path and $\frac{10}{11}$ths would go through the other. So if any extra resistance was thrown into the lamp circuit, a larger proportion of the current went round the magnets, tending to increase the potential at the machine. This was an advantage, as compared with the first form, for many purposes, but it also had the disadvantage of being too sensitive. Mr. Brush hit upon an ingenious arrangement, by means of which practically self-regulation was obtained. He made dynamos which were steady and did not vary whether the resistance was increased or not. He not only had an alternative path, but he made his external circuit also go round the magnets. The consequence of this was that if there was any increase of resistance, the presence of the series coils had a tendency to make the magnetism go down in power, and the presence of the shunt had a tendency to make it go up in power, with the result that it remained exceedingly steady. [A third diagram, illustrating the compound-wound machine, was handed in.] There was another very great advantage. If the circuit was broken in the case of the first diagram, then the current ceased at once, and the magnets practically ceased to be magnets; the consequence was that there might be considerable difficulty when beginning again. First of all, all the mounting up had to be done, because the magnet had ceased to be anything but a very feeble magnet. There was not that difficulty with the shunt, but the shunt had its own disadvantages. What Mr. Brush did was to produce a steadier machine than had been in use before, and in which, when the external circuit was broken, so as to stop the working current, the magnets remained magnetised, although less powerfully so. He would give an instance referred to by Mr. Brush, showing the great importance of that. Dynamo machines were used largely for electro-plating, where they had to drive current through a series of chemical baths and deposit copper or silver on the object to be plated. The effect of those baths was to produce electric pressure in the opposite direction to the current from the dynamo; in fact, they showed a tendency to act like galvanic batteries, and the consequence was, if they used a dynamo of the series kind to drive current through the baths, if anything occurred to stop the dynamo, the baths instantly set up a current in the wrong way, and magnetised the magnets in the opposite direction to that required. Then the dynamo had to be stopped and with great difficulty restarted in the right direction. Mr. Brush wanted to devise a machine having the advantages of the series machine in the great power it acquired, but which had not the disadvantage of the series machine, that if the current was once broken the magnets ceased to be magnets, or became reversed. So he put the two together, and made what was now universally known as the compound-wound machine, in which the two circuits went round the magnets. Electricians had now got so skilful in the use of this invention, that although they might alter enormously the external circuit, they produced just as much current as they wanted, no matter what the resistance. This was the invention the patent for which the defendants had infringed. He would put in the specification upon which the defendants ordered three dynamos to be made, and he believed it would not be denied—it could not be denied—that the machines therein described were compound-wound—that was to say, had the double circuit of which he had spoken going round the magnets. Then he would put in the acceptance of the tender, and call a witness who saw the machines on board a steamer and carefully examined them, ascertaining that they were, as a matter of fact, compound-wound. The next question was, what was claimed in the patent? The claim relied upon was the seventh: "In a dynamo machine the wire or helix, E, having comparatively high resistance, and kept in closed circuit while the machine is running, in combination with the magnetic wire or helix, F, as commonly employed, substantially as shown in division 4." His witnesses would prove that this was not known prior to the date of the patent, and that its usefulness could not be denied. Under these circumstances he should ask his lordship for judgment.

Mr. R. PERCY SELLON, electrician to the plaintiff company, stated that legal proceedings had been instituted under the patent now in question, but the defendants in the previous case had submitted to judgment. His company had insisted upon judgment in that case, and made no compromise. Numerous

licenses had been granted in respect of the patent. The portion of the patent which had been infringed in this case was that referred to in claim 7 of the specification, which was for the method known as compound-winding. There was no doubt as to the meaning of claim 7, and the description was plain and intelligible. To the best of his belief the invention was novel at the date of the patent. He had examined the alleged anticipations, and in his opinion they were not anticipations. The invention of compound-winding was very useful and very largely adopted. The machines mentioned in the specification disclosed by the defendants, which was a specification for machines for the ss. *Ormuz*, were specified to be compound-wound.

Cross-examined by Mr. BYRNE: Did not the litigation with Crompton and Co., to which I believe you referred, result, as a matter of fact, in an agreement by which you made a rebate on special terms?—I am not acquainted with the precise terms, but I know that they consented to judgment against them.

You know there were terms?—I believe so.

I suggest to you that there was a rebate of ——* in the shilling?—It might have been so. I have no knowledge.

Are there no other machines besides those made by your company known as compound?—I know of none.

Mr. MOULTON: I believe Messrs. Crompton paid something like £2,000 towards the costs?—I do not know precisely what was paid.

Mr. R. A. DAWBARN, an engineer, stated that he had seen dynamo machines on the *Ormuz*, which he examined and found to be compound-wound.

Mr. MOULTON said he had other evidence; but in the absence of cross-examination, he had no wish to put in.

Mr. BYRNE said he was in the position that he could not now call evidence. He did not desire to take up the time of the Court in attempting to resist judgment. All he was desirous of doing was to reserve his rights in the event of the patent being, in the course of a few days or weeks, declared a bad patent.

Mr. MOULTON: That means that I get judgment, which is all that I want. I want a certificate that the validity of the patent came into question, my lord.

Mr. JUSTICE CHITTY: You are entitled to an injunction.

Mr. MOULTON: Yes.

Mr. JUSTICE CHITTY: Then the judgment is for an injunction as asked, an enquiry as to damages, costs up to and including judgment, and liberty to apply as to subsequent costs, and payment of damages on result of enquiry.

Mr. MOULTON: A certificate that the validity was proved, as a matter of course.

Mr. JUSTICE CHITTY: Yes.

BIRMINGHAM AND THE ELECTRIC LIGHT.

AT the meeting of the Birmingham Town Council last Friday, Alderman POLLACK moved that the consideration of the notice given on behalf of Messrs. Chamberlain and Hookham of their intention to apply to the Board of Trade under the provisions of the Electric Lighting Act be deferred, and that it be an instruction to the General Purposes Committee to enquire into the whole question of the supply of electricity, and to report to the council thereon, and particularly as to the advisability or otherwise of the Corporation applying for power to supply electricity within the borough. The members of the council would recollect (Alderman Pollack remarked) that the Act amending the Electric Lighting Act was passed in June. Immediately afterwards the General Purposes Committee received notice from Messrs. Hookham and Chamberlain that they intended to apply for a Provisional Order to supply electricity in Birmingham. The application for the Provisional Order, as submitted to the committee, was so framed that the committee could not assent to it. So it was referred back to Messrs. Hookham and Chamberlain, and it was only returned, amended, on the day that the committee met to consider their report, and it was, therefore, impossible for them to go into the details of the matter. There seemed to be an erroneous notion that if assent were now declined, the Provisional Order could not be obtained for another year. As a matter of fact, the assent of the local authority was not required until the middle of February, and there remained three months within which the committee and the council might consider the question. It certainly was important that the council should seriously consider whether they should apply for a Provisional Order, and thus prevent any interference with the management of the streets. The present resolution must not be interpreted as hostile to the introduction of electricity into Birmingham. The committee entertained a strong feeling that some steps should be taken in that direction, but at the same time the committee had to consult the interests of the ratepayers as well as the interests of the promoters of the present scheme. The committee had to see that if electricity was supplied to the public, the supply should be on good and reasonable terms, advantageous to the consumer. If the resolution now submitted was carried, three months would remain for the consideration of the whole question. If the committee and the council then decided to apply directly for a Provisional Order, there would be a delay of 12 months. It was quite erroneous to suppose that the committee looked at the matter simply with an eye to the interests of the Gas Committee. In 1882 the Gas Committee recommended that private companies should be permitted to lay down electric plant, and the assent of the council was actually given to an electric lighting company, though that company did not carry out the agreement, and the matter dropped. In conclusion, Alderman Pollack read an extract from a letter sent by the solicitor to Messrs. Hookham and Chamberlain, offering at any time within two years to sell their undertaking, plant, and works to the Corporation at actual cost price. This, the solicitor pointed out, not only freed the Corporation from the necessity of instant decision, but offered the best guarantee that the promoters' outlay would be judicious and economical.

Alderman JOHNSON seconded the resolution. The committee, he observed, had but one desire—that the experiment of electric lighting should be tried in Birmingham, but tried after due consideration of the important question as to whether the Corporation should itself obtain power and grant licences to other people, or whether private firms should be clothed with authority direct from the Board of Trade. It was inadvisable, pending the consideration, that there should be any general discussion.

Alderman WHITE said he understood there was no desire to put off the consideration of the subject for a length of time. He would be very sorry if the question were deferred for a year. The time had arrived when the council should take up the matter zealously. It might be felt that the gas undertaking would be to some extent imperilled by the supply of electric light, but there was a great future for gas. The council had very wisely decided a few years ago to let other people make experiments, on the understanding that when they proved successful and profitable it would be time for the council to promote electric lighting, but under the terms of sale named by Messrs. Hookham and Chamberlain—which seemed a guarantee of good faith—there seemed no need to further defer the consideration of the matter.

Mr. FALLOWS said electric lighting was no longer an experiment; his recent visits to many American cities showed that across the Atlantic the electric lighting of towns was a common fact.

Mr. OSLER expressed a hope that the council would approach the subject not only without any prejudice in favour of gas, but with a distinct desire to give facilities for the development of electric lighting in Birmingham. He knew something about the conduct of electric lighting, and hoped the Corporation would, after obtaining adequate securities for the control of the streets, leave the work in the hands of private firms.

Alderman POLLACK said that if the council obtained a Provisional Order they would have more perfect control over the streets. The resolution was carried.

THE PROPOSED ELECTRIC TRAMWAY AT GOSPORT.

AT the last meeting of the Alverstoke Local Board a recommendation was brought up by the Roads and Works Committee to the effect that sanction should be given to the scheme, promoted by the British Tramways and General Syndicate, for the running of an electric tramway through Stoke Road. In answer to the question whether the board had any security that the work would be fully carried out, it was stated that they could reserve to themselves the power of opposing before the committee of the House of Commons.

Dr. KEALY contended that the scheme was of an experimental character, and there should, therefore, be some guarantee provided that the Syndicate would eventually carry out what was now proposed.

The CHAIRMAN stated that when the Fratton tramway was proposed at Portsmouth a sum of £1,000 was deposited, which could not be withdrawn until the line was approved. If that course were adopted in the present instance a full guarantee would be provided of the work being done to their satisfaction, and of any injury to their roads being made good.

Other speakers pointed out that the contingencies which had been suggested were in reality of an unlikely description, and any delay on the part of the Board would probably prevent the Syndicate from obtaining a Provisional Order this year. An amendment having been moved to the effect that the tramway should cross Bury railway arch on the north side, and not on the south, as proposed, Mr. Cooke pointed out that the Syndicate contemplated widening the arch, thus carrying out a public improvement of the value of £500. The amendment was lost, as was also another adjourning the matter for three months. It was ultimately resolved to sanction the undertaking, with the proviso that a sum of £500 should be deposited by the Syndicate as a guarantee of good faith, this amount to remain until the whole work was sanctioned by the Board of Trade.

Electric Lighting Literature.—A new and revised edition is now in the press of "The Elementary Principles of Electric Lighting," by A. A. Campbell Swinton, and will shortly be published by Messrs. Crosby Lockwood & Co. The first edition has been out of print some little time.

* The sum mentioned was inaudible to our reporter.—EDS. ELEC. REV.

SIZES OF DYNAMO WIRES.

THE following table, issued by Messrs. Shaw and Connolly, giving the stock sizes of their dynamo wires outside the insulation for various kinds of covering, may prove of use to our readers. The covering may be plain or varnished.

SINGLE CONDUCTORS.

No. P.W.G.	Diameter bare wire.	No. I. Double lapped strong cotton.	No. II. Double lapped very fine cotton.	No. III. Single lapped and braided with strong cotton.	No. IV. Braided with special fine cotton.
	Inch.	Inch.	Inch.	Inch.	Inch.
00	·380	·408	...	·443	·400
0	·340	·368	...	·403	·360
1	·300	·328	...	·360	·320
2	·284	·311	...	·345	·304
3	·259	·286	...	·310	·279
4	·238	·265	...	·288	·258
5	·220	·247	...	·270	·239
6	·203	·230	...	·253	·222
7	·180	·206	...	·225	·198
8	·165	·191	...	·210	·183
9	·148	·174	...		·166
10	·134	·160	·152		·152
11	·120	·146	·138		·138
12	·109	·135	·127		·127
...	·100	·126	·118		·118
13	·095	·121	·113	As required.	·113
...	·090	·116	·108		·108
14	·084	·110	·102		·102
...	·080	·106	·097		·098
15	·072	·098	·089		·090
...	·069	·095	·085		·087
16	·065	·091	·082		·083
...	·060	·086	·077		·078
17	·056	...	·072		·074
18	·048	...	·064		·066
19	·042	...	·058		...

STRANDS.

No. B.W.G.	Diameter bare strand.	No. I. Double lapped strong cotton.	No. III. Single lapped and braided strong cotton.	No. V. Braided only with strong cotton.
	Inch.	Inch.	Inch.	Inch.
20	·036	·052	...	...
7/20	·108	·138	·150	·143
7/19	·126	·156	·168	·161
7/18	·144	·184	·232	·225
7/17	·168	·210	·258	·251
7/16	·195	·237	·285	·278
7/15	·216	·260	·267	·260
7/14	·252	·296	·312	·305
19/22	·150	·195	·202	·195
19/20	·180	·225	·232	·225
19/18	·240	·285	·300	·293
19/16	·325	·370	·386	·378
19/15	·360	·405	·420	·413
19/14	·420	·465	·480	·473
19/13	·475	·520	·534	·528
19/12	·545	·595	·605	...
19/11	·600	·658	·718	...
19/10	·670	·725	·730	...
37/16	·455	·500	·515	·508
37/15	·504	·560	·564	·556
37/14	·584	·640	·644	...
37/13	·665	·720	·727	...
37/12	·763	·820	·826	...
37/11	·840	·900	·905	...
37/10	·938	1·000	1·008	...

THE VOLTA PRIZE.

IT is generally known that the first Napoleon founded a prize of 60,000 francs to be awarded to anyone who should by his experiments and discoveries effect an advancement in electricity similar to those due to Franklin and Volta. This prize reduced to 50,000 francs was awarded in 1852, 1858, 1866, 1871 and 1882 and 1887. On this last occasion the prize was awarded to M. Gramme "for the progress which he had introduced in the construction of dynamo-electric machines."

About 30 years ago the "Alliance" Company were working a patent for a machine with permanent magnets. Their workshops were directed by a Belgian of great merit, Joseph Van Malderen. This man in 1860 took into his employ as model-maker, a countryman of his own, Zenobe Gramme, a joiner by trade, who was then working in Paris. Possessing a rare power of reflection, the model-maker sought to understand the strange machines on which he was employed. Two years afterwards he met with new matter for reflection in the workshops of Ruhmkorff where he was employed on the wooden supports of electrostatic machines.

As he had barely learnt to read and write he was but ill-prepared to understand the language and the explanations which he heard, and he, therefore, sought to form the personal acquaintance of the agent capable of producing the extraordinary effects which he witnessed. He bought an elementary treatise on physics, which he read with great difficulty and almost word by word by the aid of a dictionary. His laboratory was the humble kitchen of a workman's house, and his apparatus consisted of a plate of gutta-percha, two magnets, and a few kilos of copper.

In a patent dated February 26th, 1867, for improvements in machines with alternating currents, he described an electric pinion formed of bobbins coiled round the projecting teeth of an iron circle, and he indicated the principle of the excitation of inductor electro-magnets by the current of the induced bobbins.

The year following Gramme constructed in London, where he was then staying, his first continuous current machine. The electromotive force must exceed 3,000 volts, but the difficulty of insulating the neighbouring wires to a sufficient extent caused him to renounce for the time being machines of high tension.

In 1869 he constructed a new machine with a magnet of 10 kilos and a ring covered with wire. The essential part of this machine, which now bears the name of the Gramme ring, is well known. The principle of the machine seems now very clear if we do not enter into the complex nature of the phenomena produced, but it was unforeseen and its capabilities seemed by no means free from doubt.

It must be admitted that the principle was not novel, and justice requires that the merit of it be attributed to Pacinotti. This savant in June, 1864, gave in the *Nuovo Cimento* an account of a small electro-magnetic machine, the essential feature of which is a ring analogous to that of Gramme.

It is, however, very probable that Gramme had never heard of Pacinotti's machine which was scarcely mentioned in the scientific literature of the day, and which attracted little attention prior to the success of the Gramme machine.

In 1871 Gramme's machine with four poles was exhibited to the Academy of Sciences by M. Jamin.

Since 1854 MM. Christofle had attempted unsuccessfully to substitute magneto-electric machines for the batteries which they employed in electro-metallurgy. Being struck with the results obtained by M. Gramme they submitted to him the following problem :—

To construct a machine which, moving at the rate of 300 rotations per minute, shall deposit 600 grammes of silver hourly upon a given surface in four baths connected in derivation.

Three months afterwards Gramme submitted to MM. Christofle a machine which fulfilled all the above conditions. This result was the starting point of an absolute transformation in industrial electro-chemistry. Two years afterwards the inventor constructed for Wohlwill, of Hamburg, a machine giving a current of 3,000 ampères with an electromotive force of 8 volts and precipitating 800 kilos. of copper in 24 hours. From that date batteries have disappeared from electro-metallurgic workshops.

Gramme, now his success was secured, continued incessantly engaged in effecting improvements of detail in his machines, creating every year new types for lighting up ships, workshops, light-houses and open

spaces either by means of continuous or alternating currents, for the distribution of power in workshops, for electro-chemical operations, &c. His machines took all forms, with two poles or with many, with moderate or great fields, with low or high tension, heavy or light, elegant or rough, but always suited to the requirements of industry or to the kind of work for which they were intended.

He turned his attention to all the accessory conditions of practice, such as the regulation of lamps, the automatic regulation of the speed of a motor in the transfer of power, giving everywhere proof of an ingenious and practical spirit.

Gramme worked alone; he combined the plans and the details of his conceptions without any assistants. He did not love to exhibit himself. He persistently avoided every occasion where he might be troubled with laudations. It even happened that an illustrious foreign savant, who had vainly sought for an interview with him, humorously questioned his existence.

Since Gramme's invention the industrial applications of electricity have undergone a rapid development in all countries. A great number of inventions have followed in the same track, and models of dynamos have become almost infinite in number, but those which yield continuous currents have nearly all the Gramme ring as a feature in common.

Science itself has derived the greatest profit from this progress. Thanks to the employment of these machines, physicists have now at their disposal currents which could not have been obtained with batteries.

The name of Gramme cannot, indeed, be placed in the same rank as those of Ampère and Faraday. His work has not even the same merit as the invention of the telephone, for which Graham Bell has been rewarded. But, in the language of the mathematical and physical class of the Institute, "it forms a memorable epoch in the history of electricity."

The discovery of Volta had remained in the laboratories. The industrial applications were very limited, in spite of the efforts and the hopes which Faraday's discovery had called forth. Since the researches of Gramme electricity has taken its place in industry along with steam, and its *rôle* extends day by day.

In awarding the Volta prize to Gramme the Commissioners believed that they were acting in accordance with the views of the founder and the programme marked out by the class of the Institute. It is convinced that its decision will meet with the unanimous assent of savants, of practical men, and of all who are interested in the progress of science and industry.

ACME ELECTRIC WORKS.

As an illustration of the rapidity with which the electrical industry is now developing, it is interesting to note in how short a time large business concerns may be built up by those capable of giving sustained attention to the requirements of the day, and possessing the necessary means, pecuniary and otherwise, of meeting demands as they arise. Quite a number of what are now important and prosperous electrical firms were more or less in embryo not more than one, two or three years ago. A striking instance of this is to be found in the business carried on from January of the present year, up to a few weeks since, at No. 45, Tabernacle Street, Finsbury, as the Acme Electric Works, under the management of Messrs. Cockburn and Day, now removed to Ferdinand Street, Chalk Farm, Mr. Arthur C. Cockburn becoming, at the same time, the sole manager. The new premises, when completed and fully equipped, will form one of the finest establishments of the kind in London. The main building consists of three floors, all well lighted, and having a total floor space of over 12,000 square feet; besides which, there is a detached erection containing a carpenter's shop, a room in which are carried on the operations of lacquering and polishing, and another in which are made and packed the well-known Cockburn fuses, the manufacture of which was the foundation upon which the present extensive business has been so rapidly built. On vacant land behind the factory a brass foundry is being erected, so that very shortly provision will have been made for turning out all classes of electric light fittings. In the meantime good use is being made of the premises as they stand. On the ground floor of the main building are the engines and heavy machinery, and it is on this floor that all goods are finally dealt with, by being warehoused or packed for despatch. Here, also, are the offices in which are conducted and recorded the commercial transactions of the firm. The first floor is pretty well covered by drilling and other machines, and light lathes, many of them constantly employed upon the various operations necessary in the construction of slate-base cut-outs and switches. Here, also, are designed and built up the large switchboards such as are required for hotel and club installations, some of the switches for such purposes being marvels of elaborate combination. Among other things in progress in this room are some new lightning arresters for high potential circuits, and a special arrangement of cut-outs and switch, enclosed in glass-fronted boxes, for the landings of electrically-lighted mansions, some of those at the moment in process of finishing being destined for the house of an English physician, not altogether unknown either in his own country or in Germany.

On the top floor a number of skilled workmen are engaged in the construction of Morse instruments, telephones for the New Telephone Company, telephone switchboards, and Profs. Ayrton and Perry's measuring instruments. Of the latter, a large number have to be completed by the end of January, to meet a special requirement. The firm makes its own screws and terminals, expensive machines being employed, which turn out complete screws from the metal rod with wonderful rapidity. A portion of this floor is enclosed, and in process of being fitted up as a testing laboratory, which when completed is expected to rank as one of the most complete in existence, Profs. Ayrton and Perry taking a strong personal interest in the perfection of the arrangements. The operations of the firm include almost every branch of electrical work, some of the most recent being the plant for the arc lighting in use at the new soap works at Barnes, and the equipment of a telegraph system, 400 miles in length, for a foreign government; even the Morse ink being made on the premises. We are glad to see that the management of the works has been put into the hands of Mr. Sudworth, whose large experience well qualifies him for such a position. The aim of the management is to be able to turn out goods of the best workmanship in large quantities at the shortest notice; and, from all that came under our notice at the time we gathered the above particulars, we could not but conclude that at the Acme Electric Works there is both the disposition and the means to do so.

REVIEWS.

The Theory and Practice of Absolute Measurements in Electricity and Magnetism. By ANDREW GRAY, M.A., F.R.S.E. In two volumes. Vol. I. London: Macmillan & Co.

THIS work is stated to be an extension of the well-known small book of the author published in 1884, but actually it may be considered to be an entirely new production, so little resemblance does it bear to the original volume. Briefly, the book consists of a sketch of the theory of electrostatics and flow of electricity, chapters on units, general physical measurements, electrometers, comparison of resistances, comparison of capacities, and measurement of specific inductive capa-

cities, and concludes with tables of units, resistances, and useful constants.

Chapter I., which is entitled "Electrostatic Theory," is almost purely a mathematical dissertation, and much of the ground gone over has been covered by Maxwell and others, though a good deal of original matter is included.

In Chapter II., on the "Theory of Flow of Electricity," the more practical questions relating to the arrangement of batteries and conductors are considered, the theory of the working of long submarine cables being given at some length, though here we see the hand of the pure theoretician, who seems unable to plainly show the practical results which follow from the theory. The chapter on "Units," which follows, does not strike one as presenting the subject in a particularly novel way, though possibly its introduction is necessary to make the subject complete. Coming to Chapter IV., on "General Physical Measurements," we have a great deal of useful information relating to the measurement of angular deflections, though a few more skeleton illustrations would be an advantage, and a few plain numerical examples are badly wanted; in fact, this absence of numerical examples is, in our opinion, a very great defect, as it most materially detracts from the value of the book. Chapter V. deals with "Electrometers," the various forms in which these instruments are made, and the way to manage them, are pointed out. We next have a chapter (VI.) on the comparison of resistances, which may be read with great profit by those who are much engaged in making such measurements, though, at the same time, it must be confessed but very little information is given which cannot be found in other text-books. In speaking of De Sauty's method of comparing electrostatic capacities (Chapter VIII.) we are informed that "it is convenient for the comparison of the capacities of condensers in which electric absorption does not come into play." Now, we very much doubt if the author has even tried the method, for, as a matter of fact, it is such an exceedingly insensitive one that results of any accuracy worth speaking of cannot be obtained; practical balance, in fact, is obtained on the galvanometer long before a true balance is obtained. The last chapter deals with measurements of specific inductive capacity.

Taking the work altogether we must confess to being disappointed at it, and we do not think that in writing it the author has done himself justice. The original work, though small, was excellent of its kind, but the enlarged edition (judging from the first volume) by no means bears out the traditions of the old.

The Elements of Electric Lighting, including Electric Generation, Measurement, Storage, and Distribution. By PHILIP ATKINSON, A.M., Ph.D. New York: D. Van Nostrand.

THE object of this volume is to meet the demand for a complete, comprehensive treatise, setting forth the various facts pertaining to electric lighting in plain language, devoid of technicality and perplexing mathematical formulæ, from which business men, mechanics, and those who have the management of dynamos and lamps, as well as general readers, may gain a knowledge of the principles and construction of the apparatus by which this light is produced, and of the nature of that invisible, intangible agency which is its prime cause. It is disappointing in the extreme, therefore, to find that Mr. Atkinson's volume does not in the least degree come up to the ideal which we had been led to expect. He admits having freely consulted the works of Thompson, Schillen, Maier, Gordon, Niaudet, and Gladstone and Tribe, and with information supplied by the various companies whose apparatus is more or less advertised, and the free use of the technical journals, he has compiled the matter now under review. The book is neither complete nor comprehensive, and the information contained therein is in many cases quite inaccurate.

From the little volumes of Bromley Holmes, Swinburne, and Rankin Kennedy, and the papers of Reckenzaun, very much more can be learned concerning electrical units, electrical measurements, electrical distribution, alternating current dynamos, and secondary batteries than from the so-called complete and comprehensive treatise of Mr. Atkinson; in fact, we do not think it in the least worth the while of any English electrical engineer to procure a copy of Mr. Atkinson's book, which, after all, deals mainly with things American, and which are not likely, except in one or two instances, to make their way over here.

Report of the Special Public Lighting Committee of the Detroit Board of Aldermen. Detroit: W. F. Moore, City printer, Butterfield Building.

This pamphlet of 106 pages is a valuable contribution to the subject of public lighting, and, although issued only to members of the Detroit Board, we imagine that no difficulty would be experienced in procuring copies by any electric lighting contractor who applies for the same. There is nothing like it published in this country, and it opens up a vast field for speculation on the ultimate result of high-tension systems employing underground wires. We have referred to this interesting compilation at somewhat greater length in our leading pages.

NEW PATENTS—1888.

15508. "Improved methods of producing aluminium and its alloys by means of electricity." L. Q. BEIN and A. BEIN. Dated October 29.

15530. "Improvements in electric indicators." R. W. PAUL. Dated October 29.

15550. "Improvements in apparatus for telephonic communication." J. SACK. Dated October 29.

15601. "Improvements in the manufacture of electric bell-push fittings." C. J. HARCOURT. Dated October 30.

15612. "Improvements in insulators for electrical conductors." J. C. LOVE. Dated October 30. (*Complete.*)

15626. "Improvements in electric batteries." P. SCHOOP. Dated October 30.

15648. "Improvements in electric switches." W. B. CLEVELAND. Dated October 30.

15658. "Improvements in electro-magnets and their armatures." H. MARRIAN. Dated October 31.

15713. "An improved connector for electrical conducting wires." Sir D. L. SALOMONS and H. FARADAY. Dated October 31.

15741. "Improvements in dynamo-electric machines." P. V. MCMAHON. Dated November 1.

15766. "Ensuring the permanence of direction on the part of an electric current." C. BULMAN and A. B. TIFFEN. Dated November 1.

15801. "An improved joint for electric light fittings." A. B. BLACKBURN. Dated November 2.

15865. "Improvements in multiple printing telegraph apparatus." C. J. MUNIER. Dated November 2. (*Complete.*)

15868. "A process of reduction of aluminium by electrolysis." A. WINKLER, A. KHUNT, and R. DEISSLER. Dated November 2.

15869. "Improvements in electro-magnetic induction apparatus." C. B. HARNESS. Dated November 2.

15877. "Pocket or portable secondary batteries or accumulators." E. ROUSSEAU. Dated November 3.

15910. "Improvements in galvanic batteries." L. KAYSER. Dated November 3. [Date applied for under Section 103 of the Patents, &c., Act, 1883, April 13, 1888.]

15915. "Improvements in electric arc lamps." F. V. ANDERSEN. Dated November 3.

15921. "An improvement in electric railway signals." A. SIEMENS. Dated November 3.

15928. "Improvements in electrical motive power engines." E. DUVALLE and A. DOUSSON. Dated November 3.

15935. "Improvements in the production of oxygen and hydrogen in large quantities by means uf the electrolysis of water, applicable for ballooning and other uses." D. LATCHINOFF. Dated November 3.

15947. "Improvements in systems of electric traction for railways and tramways." C. B. BURDON. Dated November 5.

15949. "Improved methods of applying electricity to a general system of traction." T. PEASE and C. B. BURDON. Dated November 5.

15961. "An improved electrical fabric for medical purposes." T. FIELD, jun. Dated November 5.

15985. "Improvements in or connected with mariners' compasses." G. W. ATKINS. Dated November 5.

15989. "Improvements in dynamo-electric machines and electro-motors." B. J. X. GOSSELIN. Dated November 5.

16001. "Repeating railway signals on a locomotive engine by the aid of electricity." J. GARDNER. Dated November 6.

16005. "Utilising existing telephone line wires for clock synchronising or controlling purposes." A. G. BURRELL. Dated November 6.

16025. "Improvements in automatic measuring supply and delivery of air, gas, electricity, and like force, also liquids, by the introduction of a coin or any given weight." S. BUNTING. Dated November 6.

16047. "Improvements in magneto-electric railway signals." W. P. THOMPSON. (Communicated by The Pennsylvania Steel Company, United States.) Dated November 6.

16048. "Improvements in or relating to secondary or storage batteries." W. P. THOMPSON. (Communicated by C. H. Thompson, United States.) Dated November 6.

16054. "An improved apparatus for the delivery of electricity." C. WELLS. Dated November 6.

16099. "Improvements in the construction of electrical switches, cut-outs, ceiling and wall connectors." C. M. DORMAN and R. A. SMITH. Dated November 7. (*Complete.*)

16129. "An improvement in the contact makers of electrical alarms for doors and windows." J. E. LANSARD. Dated November 7.

16140. "Improvements in the charging of secondary electric batteries from primary batteries, and apparatus for that purpose." E. TYER. Dated November 7.

16141. "Electrical contact apparatus worked by passage of a railway train." E. TYER. Dated November 7.

16146. "Improvements relating to electro-medical batteries." F. MORETON. Dated November 7. (*Complete*)

16202. "Improvements in and connected with electrical billiard-marking apparatus." J. J. HINE. Dated November 8.

16212. "Improvements in phonographs or apparatus for recording and reproducing sound, and in phonograms or surfaces for receiving sound records and in envelopes for such phonograms." G. E. GOURAUD. (Communicated by T. A. Edison, United States.) Dated November 8.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1887.

10009. "Improvements in electric railway signals." G. H. WRIGHT. Dated July 16. 11d. Consists in certain novel construction and combination of signal setting mechanism, stop mechanism, controlled by electro-magnets in electric circuits, and a circuit closing mechanism located in the roadway at given points along the line, and adapted to vitalise the magnets when acted on or set in operation by the moving train, all as described and pointed out in the claims. The claims are 8 in number.

13080. "Improvements in and relating to dynamo-electric machines." W. FEITSCHE. Dated September 27. 1s. 1d. Is mainly characterised by the fact that the whole of the wires or rods are arranged in two series or groups, symmetrically inclined in the direction of the motion, and so connected together that, in starting from one point, the whole or any part of the wires may be followed, and by so doing, the starting point can be reached again. The claims are 4 in number.

13853. "Improvements in and connected with telegraphic apparatus for transmitting orders or other communications." G. A. CALVERT. Dated October 13. 8d. Claims:—1. In telegraphic apparatus for transmitting orders or other communications, the combining of mechanical telegraphic apparatus with an electric circuit having in connection one or more electric bells, and with commutator or contact appliances arranged to start the ringing of the bell or bells when a transmitting movement is made, and to stop the ringing when a corresponding acknowledging movement is made, the parts being arranged and operated substantially as and for the purposes described. 2. Combining with engine room telegraphic receiving instruments devices for locking and unlocking the starting or reversing lever of a main engine, or of a starting engine, the said devices being substantially such as are described. 3. Combining telegraphic apparatus of the kind claimed for general purposes in the first claiming clause hereof with steering engines or gear, substantially in the manner and for the purposes described.

13960. "A novel combination of spring jack and lightning arrester for use in or with a test board for telephone wires, and means of carrying, and a method of arranging any required number of sets or apparatus formed of such combination, such invention being applicable also for the purpose of a telephone switchboard, and for other analogous electrical purposes." A. COLEMAN and H. F. JACKSON. Dated October 14. 8d. Consists of a novel combination of spring jack and lightning arrester. The slipper of the spring jack is carried upon a shelf of wood or other insulating material, which is itself fitted into a vertical frame, from which it may be readily withdrawn when desired. The slipper is turned down at the front against the front edge of the shelf, but extends a short distance only across such edge, and such turned down part is, preferably, of the width of the slipper. A conductor formed preferably as a flat strip is fixed along the front of the shelf in position to be out of contact with the turned down part of the slipper. A small plate of suitable conducting material, and, preferably, of the width of the slipper, is fixed against the front of the conductor which is along the front of the shelf, and in position vertically below the turned down part of the slipper, by means of a pin or screw passing through a vertical slot in such plate so that the plate can be readily and accurately adjusted as to its distance from the lower edge of the turned down part of the slipper. The lower edge of the turned down part of the slipper and the upper edge of the plate form between them a lightning arrester, and are serrated, or otherwise formed with a number of points, as is common in apparatus for such purpose. The claims are 3 in number.

14390. "An electric firing fuse or primer." R. MORRIS. Dated October 22. 8d. The inventor makes a capsule like a small cartridge case with a hole through its bottom. Through this hole he passes an insulated conducting wire and surrounds it by a plug or wad of paper compressed into the capsule to steady the wire and act as a gas check. To the end of the wire exposed beyond the wad and to the edge of the capsule he solders a small piece of fine platinum wire or foil. He forces the capsule thus prepared into a cartridge or charge chamber which he charges with explosive, then this cartridge or charge chamber being connected through earth or otherwise with one terminal of an electric generator, when the wire is also connected with the other terminal and an electric current transmitted, the platinum connection of the wire to the capsule becomes heated and fires the explosive. The claims are 2 in number.

14528. "Improvements in microphones." C. BELL. (A communication from abroad by L. M. Ericsson, of Stockholm.) Dated October 25. 8d. Claims:—1. The construction, or arrangement and combination of the parts of a microphone, substantially as described in reference to and shown in the drawings. 2. The construction and use of a microphone, in which the current is carried to the carbon block and diaphragm by a pin or pencil, the two ends of which make loose contacts, the upper with the diaphragm, and the bottom end with a metal cup supported on a regulating spiral spring, the pin resting loosely in the cup, and the whole placed inside a case and adjusted by a regulating screw, all substantially as described in reference to and shown in the drawings.

14658. "Improvements in electric indicators." G. E. FLETCHER. Dated October 28. 8d. Relates to a compound needle which is substantially as follows:—It is of horseshoe shape with a piece of iron wire, block of iron or steel placed tangentially to it, and at right angles to its axis on which it rocks, and which may be either horizontal or vertical. This needle is kept in its normal position by magnets which may be either electro or permanent magnets. It is obvious that these magnets become the inducing magnets. The ends of the horseshoe shaped needle dip into two hollow bobbins or coils, which are wound with insulated wire, and have their axes vertical or horizontal as the case may be, but in all cases at right angles to the axis of the compound needle. When a current is sent in one direction through the coils one end of the needle is drawn into one of the coils and the other end is repelled by the other coil. With a reverse current the effect is opposite. The claims are 3 in number.

14996. "Improvements in gear for transmitting motion from electric motors to driving axles of vehicles." E. HOPKINSON. Dated November 3. 8d. Claims:—1. For transmitting motion from electric motors to driving axles of vehicles, a carrier wheel between the driving and driven wheels, mounted substantially as described, so that it has freedom of angular motion round the driving and driven wheels, compensating for change in their relative positions. 2. For transmitting motion from electric motors to the driving axles of vehicles, the combination of a flexible coupling and carrier wheel with bevel or worm gearing, arranged in the manner substantially as described, and for the purpose indicated.

15385. "Apparatus for disinfecting impure liquids by electrolytic action." E. HERMITE, E. J. PATERSON, and C. F. COOPER. Dated November 10. 8d. The inventors provide at an outlet a sluice, on the lower edge of which they fix one electrode in the form of a plate of considerable width, and on the sill of the sluice they fix another corresponding electrode. On the sluice being raised a little way, the liquid previously mixed with chloride flows in a comparatively thin sheet between the electrodes. These being insulated and connected by insulated conductors to the terminals of a dynamo-electric machine or other electric generator, a current of electricity passes through the liquid and disinfects it. The claims are 4 in number.

15660. "Improvements in electric clocks." A. J. THOMAS. Dated November 15. 8d. Relates to a system of electrical transmission of motion from a primary self-winding electric clock to any number of secondary or receiving clocks, which may or may not be provided with striking trains. The primary clock, which is simple in construction and certain and regular in action, is self-winding by each emission of the current for actuating the secondary clocks, and it is provided with a peculiar form of contact whereby the isochronal passage of the current is established. The claims are 3 in number.

CORRESPONDENCE.

Deep Sea Soundings.

In the important paper read before the Society of Telegraph-Engineers last week by Mr. W. Lant Carpenter, an allusion was made when dealing with instruments used to determine the temperature of the ocean to the weak point in the ordinary thermometer—the fact that this instrument only registers maxima and minima temperatures, and need not necessarily record the temperature at the lowest depth to which it is lowered.

An instrument has been devised by Mr. J. Y. Buchanan, F.R.S., called the mercury piezometer, which gets over this difficulty, and as it is but little known, and has been very successfully used on recent Norwegian deep sea expeditions, I venture to think that a brief description may be of interest.

The piezometer is nothing more than a Six's thermometer with one end open. Its form is that of a ∩-shaped tube having a large bulb at one end filled with mercury, while the other dips into a mercury cup which is so fitted that, while no mercury can escape, it is open to effects of pressure. The tube is filled with water, and contains a steel index held in position by a horse hair spring, just as in the registering thermometer.

The quantity of mercury is so much greater than that of water, and its compressibility so small, that the instrument is far more affected by temperature than by pressure. In fact, an increase of depth of 430 fathoms has the same effect as a fall of 1° C. in temperature. The necessary correction for pressure is obtained from the depth to which the instrument is lowered, as given by the sounding wire. It will be seen that so long as the temperature of the sea does not *increase* with the depth at a greater rate than 1° C. per 430 fathoms the instrument will record correctly the temperature at the greatest depth to which it is lowered.

The only other instrument which pretends to do this is the capsising thermometer of Negretti and Zambra, which has disadvantages when used at considerable depths.

A full description of the mercury piezometer is to be found in the *Journal of the Chemical Society* for October, 1878, and also in the *Challenger* expedition reports.

Edward Stallibrass.

November 12th, 1888.

Sparking Coils.

The size of secondary in our spark coils is No. 39, *not* 29 as stated in your last issue by misprint.

Pyke & Barnett.

November 12th, 1888.

An interesting coil similar, at least in some respects, to the one so favourably noticed in last week's REVIEW, was described and illustrated in the *English Mechanic* of December 24th, 1875 (Vol. 22, page 368), under the heading "Another Induction Coil," and I feel sure that anyone interested in coil construction will be pleased to read the article referred to.

H. J. Coates.

Hedges on Central Station Electric Lighting.

May I be allowed to say a few words in answer to your reviewer's criticisms, as I am accused of publishing a "*rechauffé* of papers read at meetings of various societies"? I believe it is the practice of some reviewers to insert a paper-knife in the work under notice and draw their comments from the page which opens. In my case the reviewer has evidently ignored the preface, in which I state that "a paper entitled 'Central Station Electric Lighting' was contributed to the Inst. Civ. Engineers, and that my book is a reproduction of same in an extended form." Whether the method adopted by me is "*scientific*" or not, I have the satisfaction of knowing that it was the first selected paper on electric lighting considered worthy of a Telford premium, and it was the fact that all the copies of this paper were applied for which induced me to publish the work in an extended form with the view of placing before those interested in the development of electric lighting a summary of what had been practically accomplished, and a list of the central stations in England and on the Continent. With the help of correspondents and the information given in your valuable paper, I hope from time to time to add to this list not only the extensions of the lighting, but also give a statement of the profits, which is the one thing needful to induce the public to look with the same favour on electric light undertakings that they do on gas.

Killingworth Hedges.

November 12th, 1888.

A Low Ocean Temperature.

In March, 1886, the Zanzibar-Mozambique cable failed about 321 knots from the cable house at Zanzibar.

Shortly after midnight of March 13th a mark-buoy was moored by a 3½ cwt. mushroom in a mud bottom, the depth of water 490 fathoms, lat. 10° 10′ 50″ S., long. 41° 30′ 0″ E., the temperature of the atmosphere 87°, and the surface water of the sea 86°.

About 9 a.m. of the 18th the mark-buoy was picked up. The temperatures—air, 85°; sea, 86°.

The mushroom, on being brought up, was found to contain in the cavity of its concave surface a compact mass of yellow mud. A Zanzibar seaman was ordered to remove this mud, when, on thrusting both hands into the mud, he jumped up with a yell, saying that he was burnt. I immediately placed my hand on the mud, and to my great surprise found it was extremely cold. One of Elliott's standard thermometers was then placed in the mud and allowed to remain there for a few minutes. Upon its removal, the temperature recorded was 45°, a difference of 41° below that of the surface water.

It is a known fact that sudden extreme changes of temperature from hot to cold have the same effect upon the sense of touch as that of being burnt, and the cause of the seaman's cry of pain was really the shock of a chill, the man having probably never experienced so low a temperature before.

This incident is another proof, if such be wanting, that a great increase or decrease of temperature conveys an exactly similar impression to the brain.

All temperatures are Fahrenheit.

Walter Goodsall.

Bank of England Electric Lighting.

As we hear that a report has been circulated in the City with reference to the above installation which may be prejudicial to electric lighting interests, we shall be glad if you can find space for a short explanation of the facts.

We are pleased to say there is not the slightest foundation for the statement that the Bank of England is discontinuing the use of the electric light; in fact, we are at this moment engaged in fixing two large gas engines to supplement the 50 H.P. steam engine which has run without a hitch of any kind from the moment it was started. Possibly the rumour has originated through the temporary cessation of the light in the drawing office, where it has been found necessary to rearrange the early installation put down by another company some years ago; but we shall have this ready for use again shortly, and in the meantime we are pleased to notice that the short compulsory return to gas is by no means appreciated by the bank staff.

Drake & Gorham.